AIRFIELD SURVEY SPECIFICATION DOCUMENT
for the
TERMINAL AERONAUTICAL GNSS GEODETIC SURVEY PROGRAM

18 January 2005

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I. TERMINAL AERONAUTICAL GNSS GEODETIC SURVEY

PROGRAM REQUIREMENTS

1. SCOPE

The information in this specification document is intended as guidance for the surveying and collection of airfield information and data. This document addresses requirements for Global Navigation and Satellite System (GNSS) navigation specifications and accuracies.

2. PURPOSE

This specification document is intended to assure uniformity of treatment among all mapping, charting, and survey elements engaged in a coordinated production and maintenance program for this product. This specification document provides accuracies, precisions and descriptions of requirements for GNSS navigation.

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

3. APPLICABLE DOCUMENTS

Other Government documents. The following Government documents form a part of this document to the extent specified herein. Unless otherwise specified, the document versions are those cited in the solicitation.

NIMA Technical Report 8350.2 - Department of Defense World Geodetic System 1984,3rd Edition, 4 Jul 1997. (Stock Number DMATR 83502 WGS 84). This document is available at: http://earth-info.nga.mil/GandG/tr8350_2.html

Standards for Aeronautical Surveys and Related Products, FAA No. 405, Fourth Edition, September 1996, including Change 1, April 1998. This document is available at: http://www.ngs.noaa.gov/AERO/aerospecs.htm#FAA405

Other documents.
WGS 84 Implementation manual, Version 2.4, February 12, 1998. This is prepared by the European Organization for the Safety of Air Navigation (EUROCONTROL) and the Institute of Geodesy and Navigation, University FAF Munich, Germany and is available at: http://www.wgs84.com/files/wgsman24.pdf

Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

4. MAINTENANCE

The NGA Geodetic Surveys Branch maintains this document. Please address all correspondence to Mail Stop L-20, 3838 Vogel Road, Arnold, MO, 63010 or call (314) 263-4819. E-mail SURVEYS@NGA.MIL

5. HARD SURFACE RUNWAYS

Runway data shall be provided only for runways with a Specially Prepared Hard Surface (SPHS) existing at the time of the field survey. Unless otherwise stated, all runway points shall be on the runway centerline. The number painted on the runway at the time of the field survey shall identify runways. If a number is not painted on the runway, the runway number published in the "U.S. or DoD Terminal Procedures" current at the time of the field survey shall be used.

6. NAVIGATIONAL AIDS

The position of a "plot point(s)" shall be determined for certain electronic and visual NAVigational AIDs (NAVAIDs). The term "plot point" is understood to be a unique coordinate position that is determined by either geodetic survey or by photogrammetric means. The "plot point" may be the center of the NAVAID, or when the NAVAID is composed of more than one unit, the center of the. A "plot point" is required if, and only if, the NAVAID is associated with the airport being surveyed. Elevations are not required for visual NAVAIDS. However, if the NAVAID is also an obstruction, section 7 of this document may also apply.

A plot point is required for NAVAIDs meeting **all** of the following three criteria:

- The NAVAID is listed in Appendix A.

- The NAVAID is located within 7 nautical miles of the Airport Reference Point with the exception of the Airport Surveillance Radar (ASR).

- The NAVAID is, except those identified as a feeder or enroute facility, associated with an instrument approach procedure for the airport being surveyed and the procedure is published in the United States Government flight information publications " Terminal Procedures" current at the time of the field survey. This requirement also applies to Airport Surveillance Radars.

In addition to the NAVAIDs identified above, Airport Surveillance Radars located within the vicinity of the airport being surveyed, and not located on a military airfield, shall be surveyed.

6.1 ELECTRONIC AIDS

The latitude, longitude and sometimes an elevation, depending on the NAVAID, shall be determined for the selected electronic NAVAIDs associated with the airport. The horizontal and vertical plot point for electronic NAVAIDs are listed in Appendix A of this document.

6.2 VISUAL AIDS

The latitude and longitude shall be determined for all required visual NAVAIDs, NAVAIDs and their "plot points" are identified in Appendix A of this document. Reminder: Elevations are **not required** for visual NAVAIDs.

7. OBSTRUCTIONS

The controlling obstructions/obstacles as defined for existing approach/departure procedures must be surveyed to the absolute accuracy specified in Appendix B and the relative accuracy specified in Appendix C. All other objects/obstructions may be positioned either by surveying or photogrammetrical methods, whichever is most cost effective.

7.1 DEFINITION

An obstruction, for this section, is the highest object within each obstruction identification surface (OIS) zone that penetrates an OIS zone as defined in section 7.2, except where no obstruction penetrates the OIS zone, then it shall be the highest object within the area.

7.2 OBSTRUCTION IDENTIFICATION SURFACE

The OIS consists of several surfaces related to a specific runway approach. When approaches share the exact surface (no displaced thresholds) only one OIS would be required. OIS dimensions for a runway are defined below (see figures 7.1)

7.2.1 Primary Surface and Clear Zone

An imaginary surface, longitudinally centered on each runway, equal to the length of the runway plus 1000 feet on each end, and with a width of 2,000 feet (see figure 7.2).

- For the purposes of determining obstacles on the sides of the runway, the Primary Surface is referenced horizontally to the runway ends and vertically to the **lowest** runway end elevation.

7.2.2 Approach Surface

An inclined plane, symmetrical about the runway centerline, beginning 200 feet outboard of the runway end point, at the height of the runway end point and extending for 42,332 feet (7nm - 200 feet of primary surface). The slope of the approach clearance surface is 50 to 1 along the runway centerline extended until it reaches a height of 500 feet above the height of the lowest runway end elevation. For runways with different end elevations, the length of the 50:1 slope surface will be shorter for the higher elevation end. It then continues horizontally at this height to a point 42,532 feet (7nm) from the end of the runway. The width of this surface at the runway end is the same as the primary surface, it flares uniformly, and the width at 42,532 feet is 13,899 feet (see figures 7.3 and 7.4)

- The vertical reference point for the 50:1 slope surface is the height of the runway end elevation.

- The vertical reference point for the horizontal approach/departure surface is the height of the **lowest** runway end elevation.

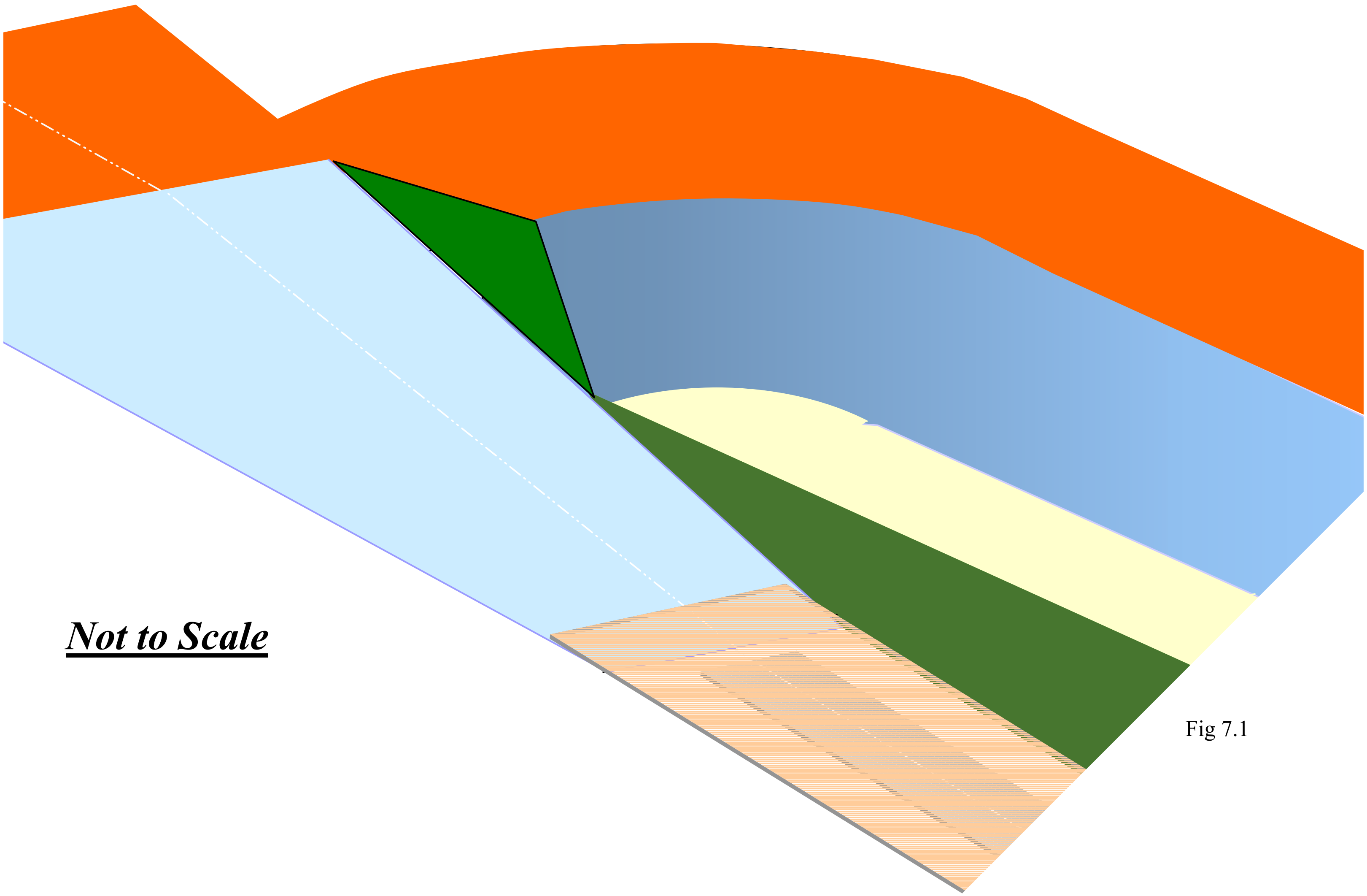
7.2.3 Primary/Approach Transitional Surface

This surface connects the side of the runway primary and approach surfaces to the inner horizontal surface (see figures 7.5 and 7.6).

1. The surface extends outward, perpendicular to the centerline of each runway, from the edges of the primary surface, at a slope of 7:1 to a width of 1,050 feet and a height of 150 feet above the **lowest** runway end elevation.

2. The surface extends outward, perpendicular to the extended runway centerline from the edge of the approach surface at a slope of 7:1, to a height of 150 feet above the **lowest** runway end elevation.

3D VIEW OF ALL OBSTRUCTION IDENTIFICATION SURFACES



Not to Scale

Fig 7.1

Top View of the Primary/ and Clear Zone Surface

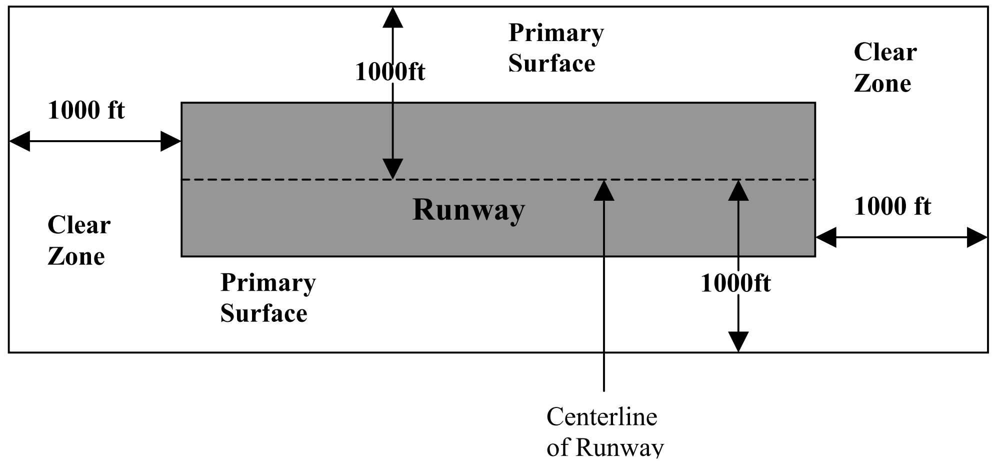


Fig 7.2

Not to Scale

Top View of Approach Surface

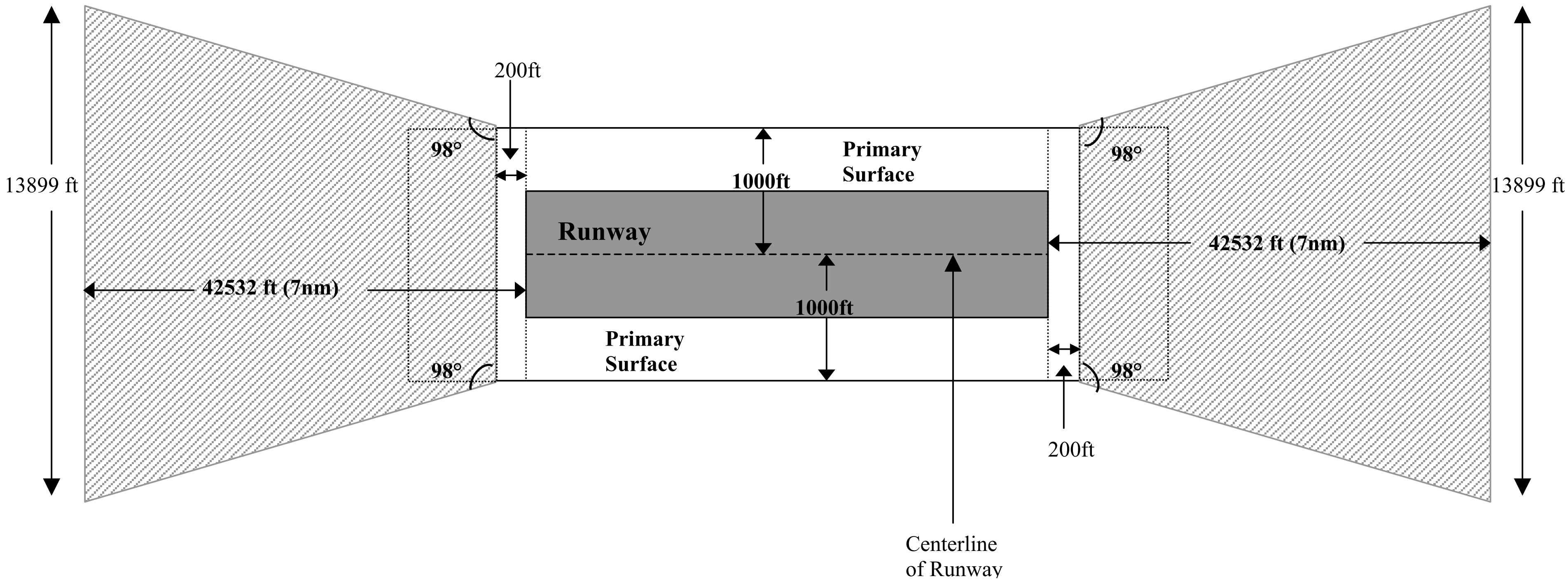


Fig 7.3

Not to Scale

Side View of Approach Surface

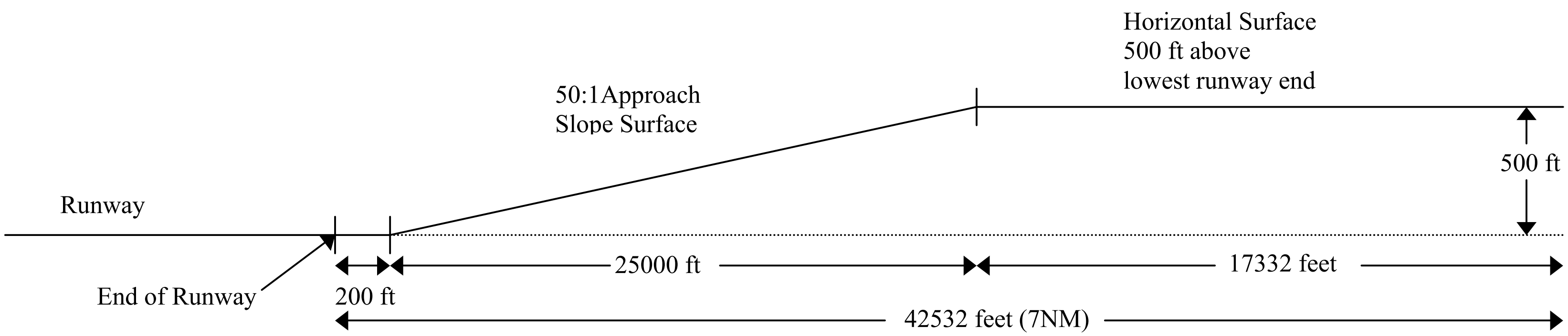


Fig 7.4

NOTE: For runways with different end elevations, the length of the 50:1 slope surface will be shorter for the higher elevation end.

Not to Scale

Top View of Primary/Approach Transitional Surface

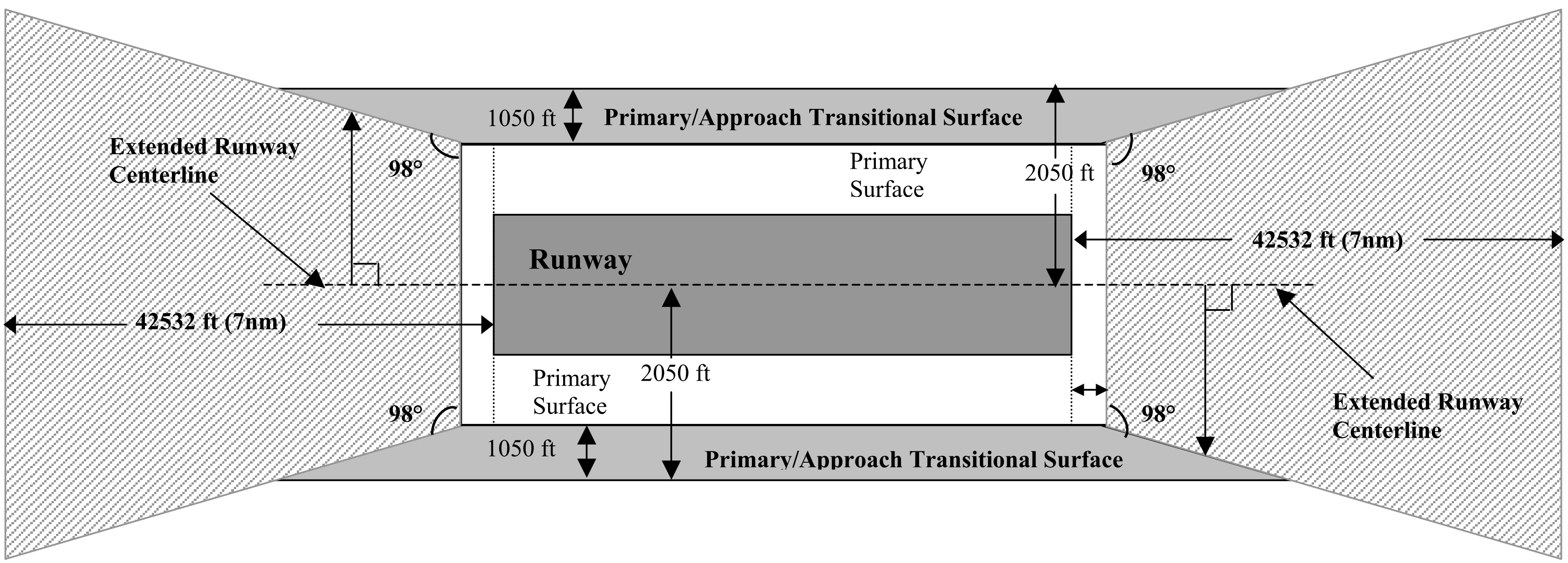


Fig 7.5

Not to Scale

End View of Runway, Showing the Primary/Approach Transitional Surface

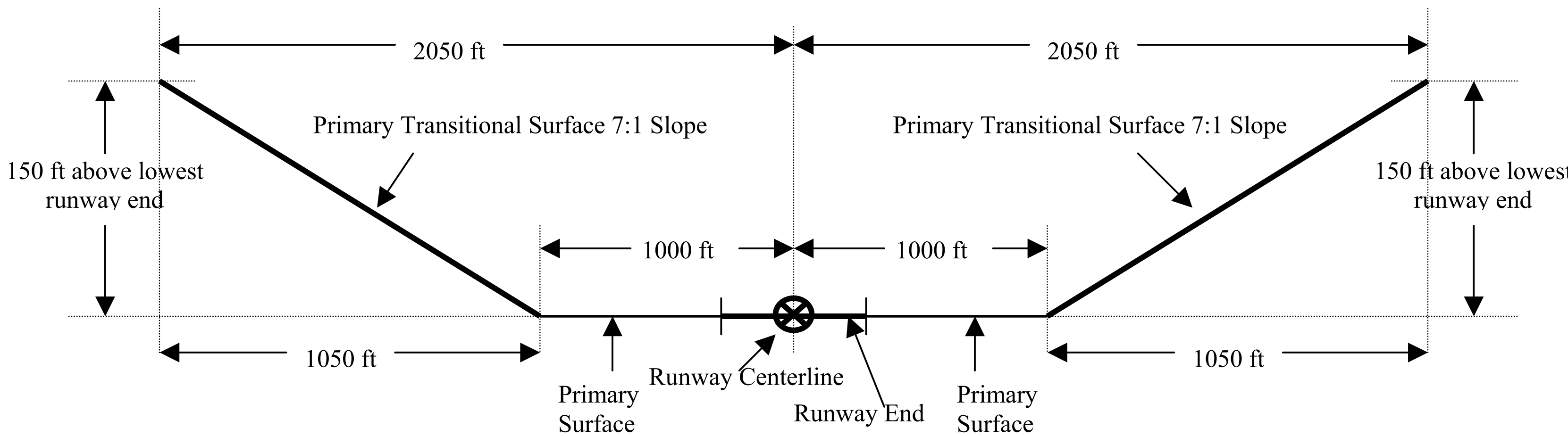


Fig 7.6

Not to Scale

7.2.4 Inner Horizontal Surface

The inner horizontal surface for each runway is defined by two half circles centered on the runway ends and joined by tangents. The radii of the half circles are 7,500 feet and the tangents are parallel to the runway centerline at a distance of 7,500 feet. The surface is a constant 150 feet above the **lowest** runway end elevation (see figures 7.7 and 7.8).

7.2.5 Conical Surface

A surface extending from the periphery of the inner horizontal surface outward and upward at a slope of 20:1 for a horizontal distance of 7,000 feet to a height of 500 feet above the **lowest** runway end elevation (see figures 7.9 and 7.10).

7.2.6 Outer Horizontal Surface

A plane, located 500 feet above the **lowest** runway end elevation, extending outward from the outer periphery of the conical surface for a horizontal distance of 28,032 feet. (see figures 7.11 and 7.12).

7.2.7 Conical/Outer Horizontal Approach Transitional Surface

This surface connects the side of the approach surface to the conical and outer horizontal surface. The surface extends outward, perpendicular to the extended runway centerline from the edges of the approach surface, at a 7:1 slope. The slope of the 7:1 surface is referenced to the runway centerline (see figure 7.13).

Top View of Inner Horizontal Surface

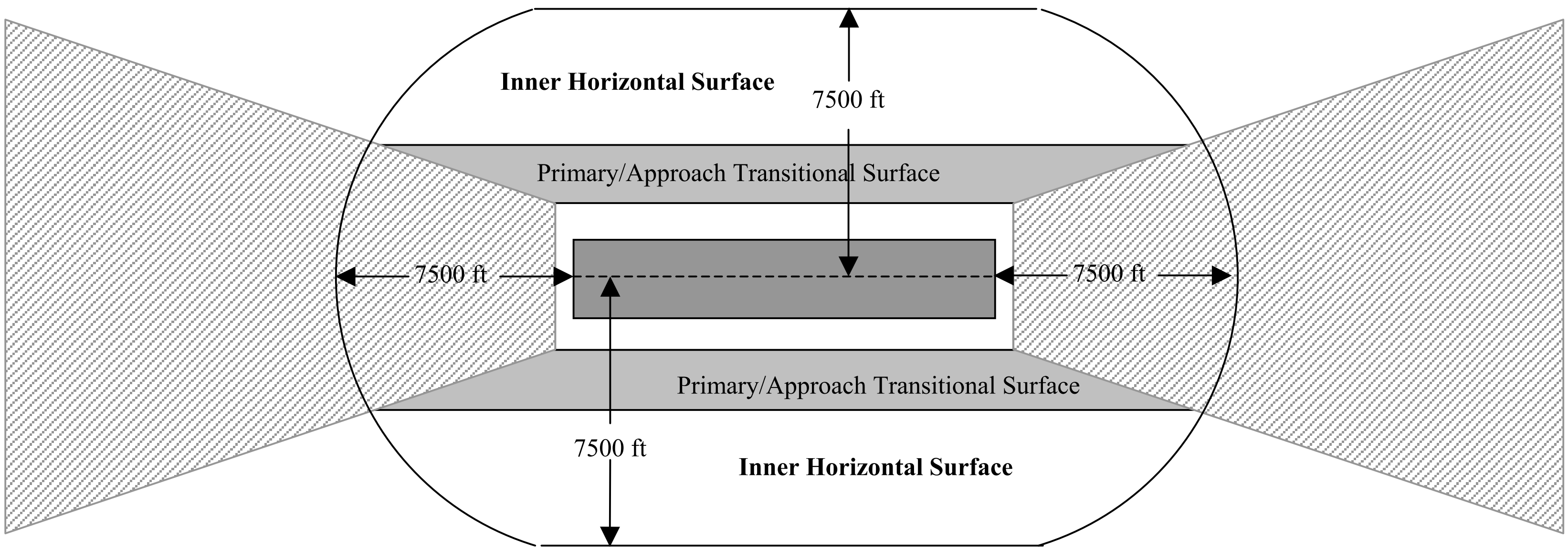


Fig 7.7

Not to Scale

End View of Runway, Showing Inner Horizontal Surface

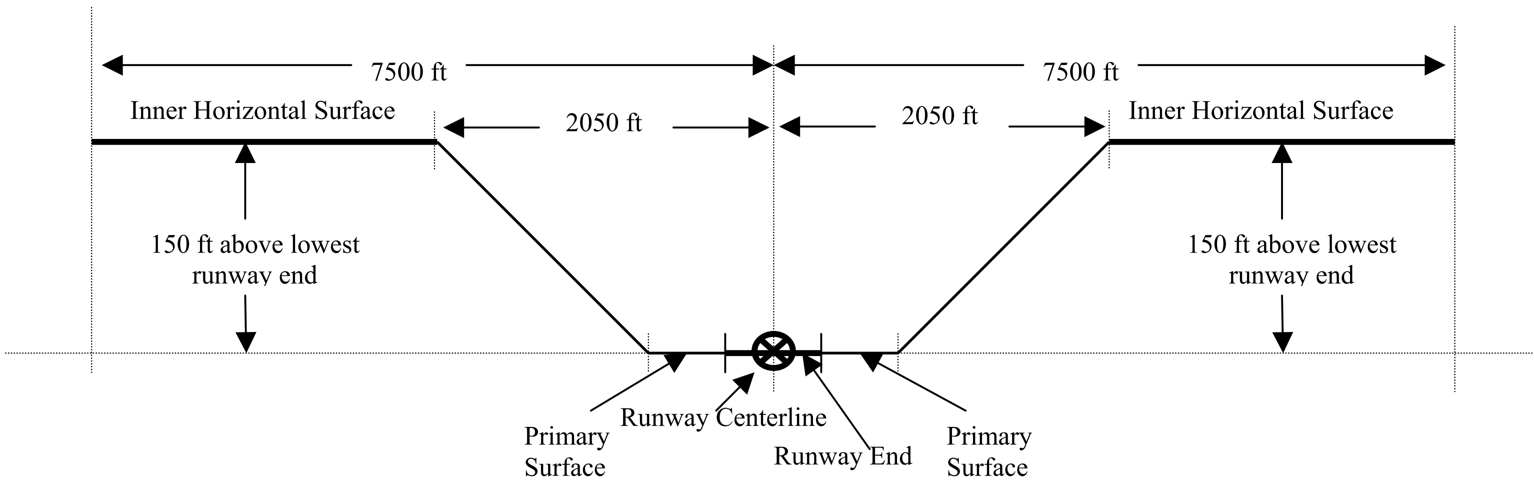


Fig 7.8

Not to Scale

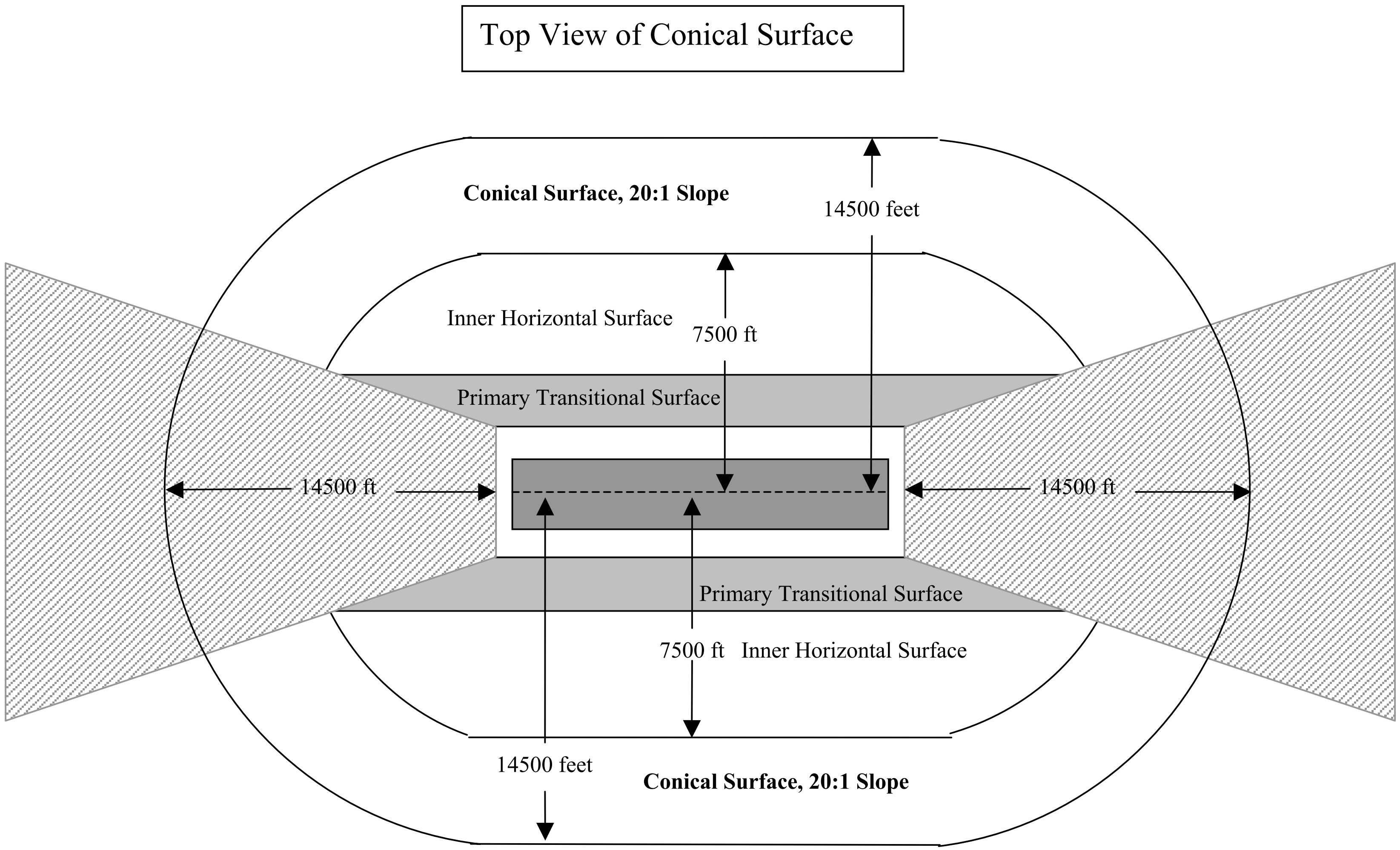

Top View of Conical Surface
Conical Surface, 20:1 Slope
14500 feet
Inner Horizontal Surface
7500 ft
Primary Transitional Surface
14500 ft
14500 ft
Primary Transitional Surface
7500 ft
Inner Horizontal Surface
14500 feet
Conical Surface, 20:1 Slope

Fig 7.9

End View of Runway, Showing Conical Surface

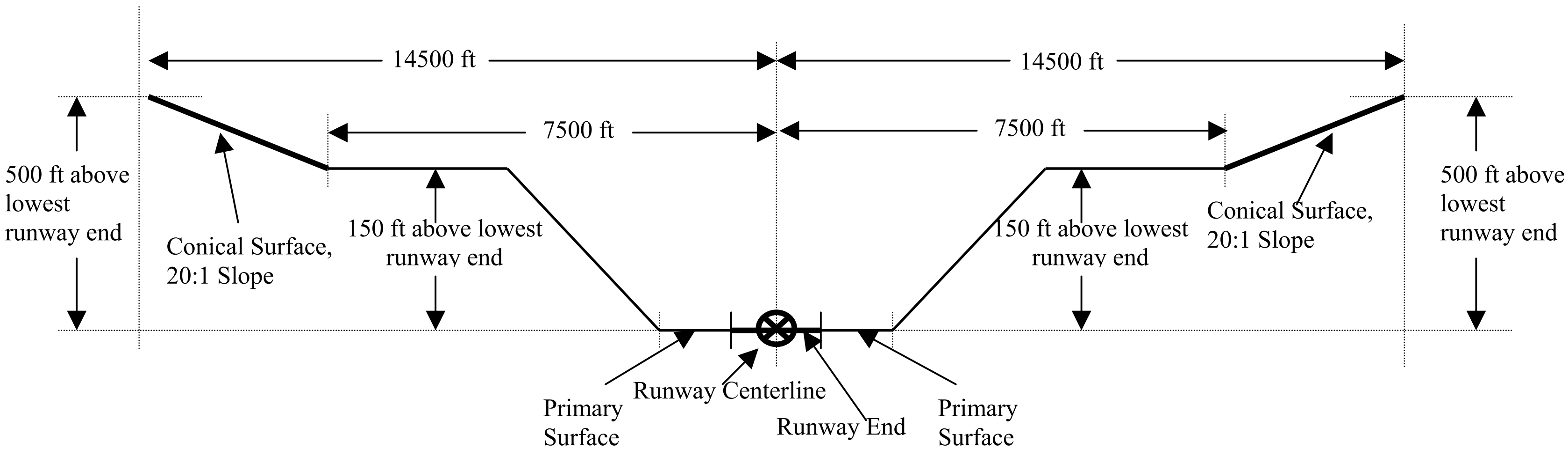


Fig 7.10

Not to Scale

Top View of Outer Horizontal Surface

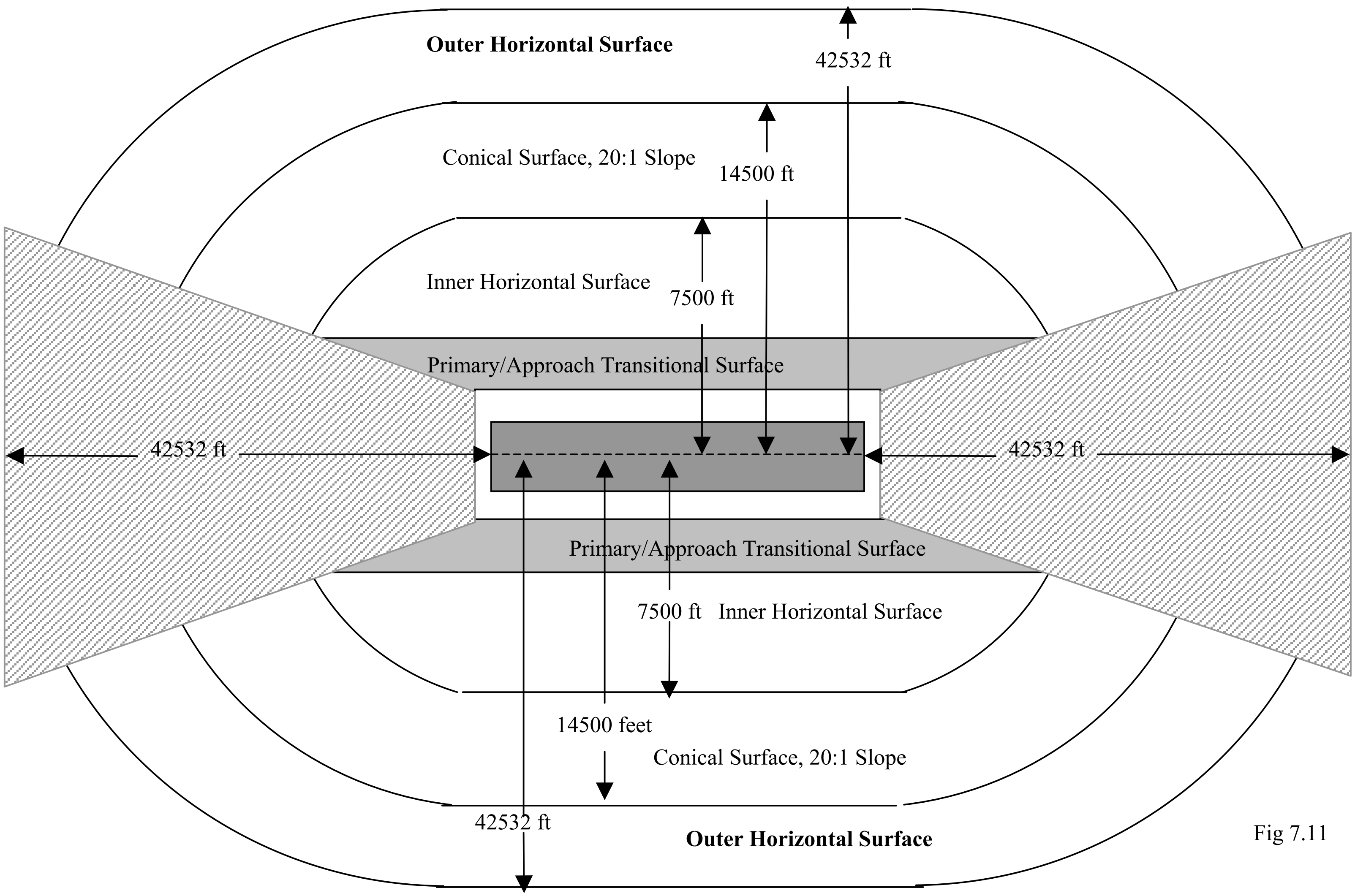


Fig 7.11

Not to Scale

End View of Runway, Showing Outer Horizontal Surface

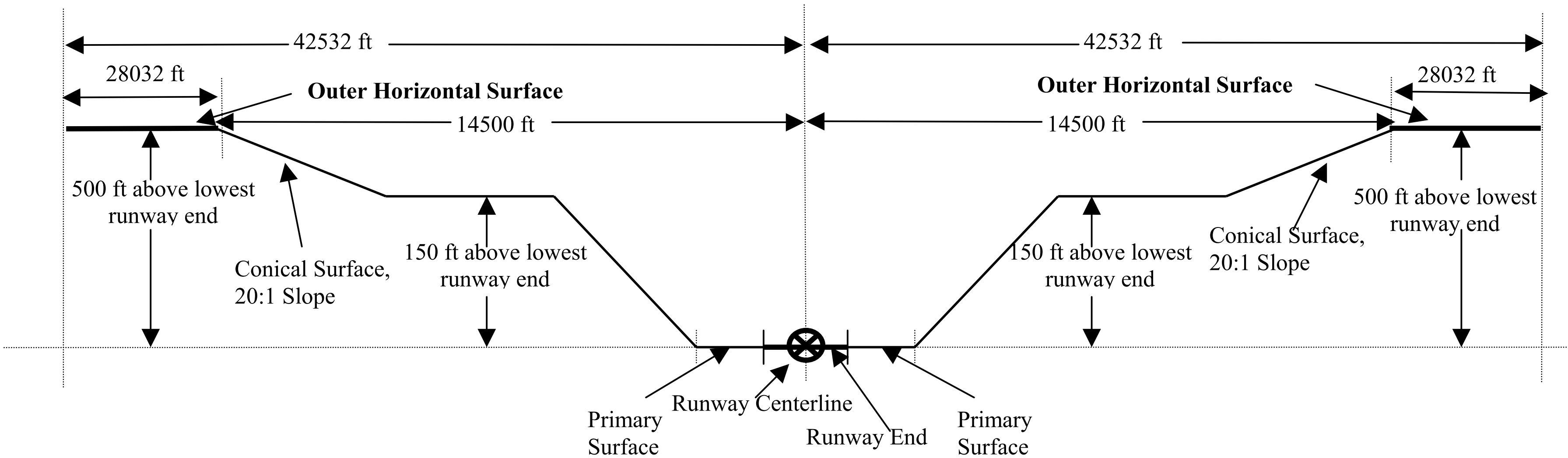


Fig 7.12

Top View of Conical/Outer Horizontal Transitional Surface

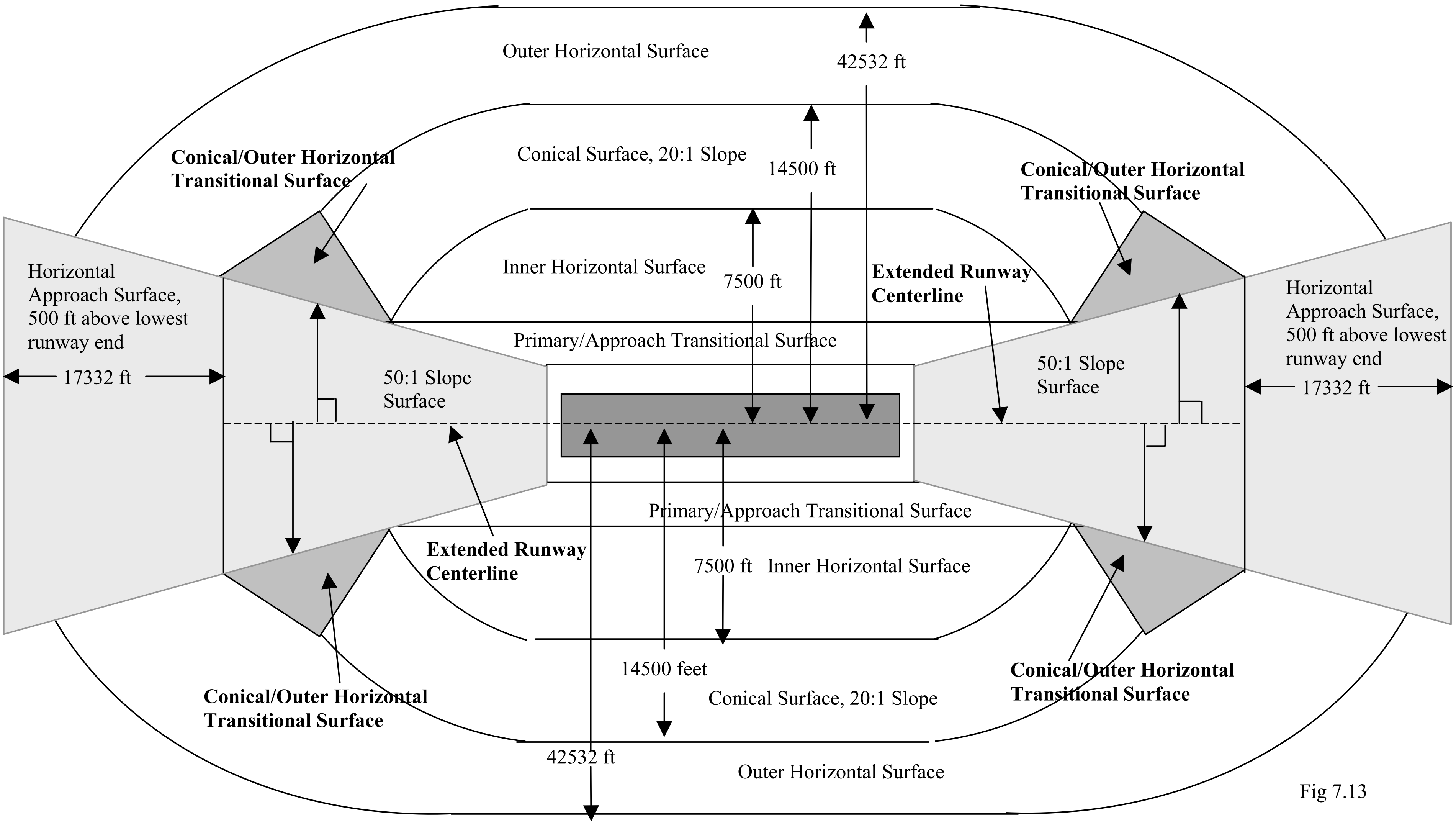


Fig 7.13

Not to Scale

7.3 SPECIAL CASES

7.3.1 Catenaries

In most cases, the position and elevation of supporting towers will adequately represent Catenaries. These towers shall be treated as any other potential obstruction. However, if one or both towers are outside the limits of the OIS, the catenary itself may become a significant obstruction. In these cases, the catenary shall be depicted as a linear feature connecting the tops of the adjacent catenary support towers at the highest point within the OIS. The elevation of this point shall be carried as an Estimated Maximum Elevation (EME).

7.3.2 Obstruction Exemptions

The following obstructions are not required to be measured:

- Vegetation that is both obstructing by less than three feet and with a maximum cross sectional diameter no greater than one-half inch where transected by an obstruction surface.

- Annual vegetation, such as annual weeds, corn, millet, and sugar cane.

- Frangible objects under the control of airport authorities within locations fixed by function. Examples are runway and taxiway signs, and many approach light structures.

- Roads with restricted public access that is intended for airport/facility maintenance only. This exemption does not apply to airport service roads associated with other airport operations, such as food, fuel, and freight transportation.

- Construction equipment and debris, including dirt piles and batch plants, that are: (1) temporary in nature, (2) under control of the airport authorities, and (3) located on airport property.

- Vessels: If a possible obstructing condition exists, a note shall be entered on survey products cautioning that vessels may obstruct certain FAR-77 surfaces at certain times and that further investigation by the product user regarding maximum vessel height, travel limits, and frequency of passage is advised. This exemption does not apply to vessels that are permanently moored.

7.4 SELECTION

Required objects/obstructions include:

7.4.1 Primary Surface / Clear Zone (See Figures 7.15 – 7.17)

- The highest obstruction/object outward from the runway end.
- The highest obstruction and the highest non man-made obstruction/object in each 3,000-foot (approximately) section of the primary area on each side of the runway.

Top View of Primary Surface / Clear Zone Obstructions

6,000 to 9,000 foot runways

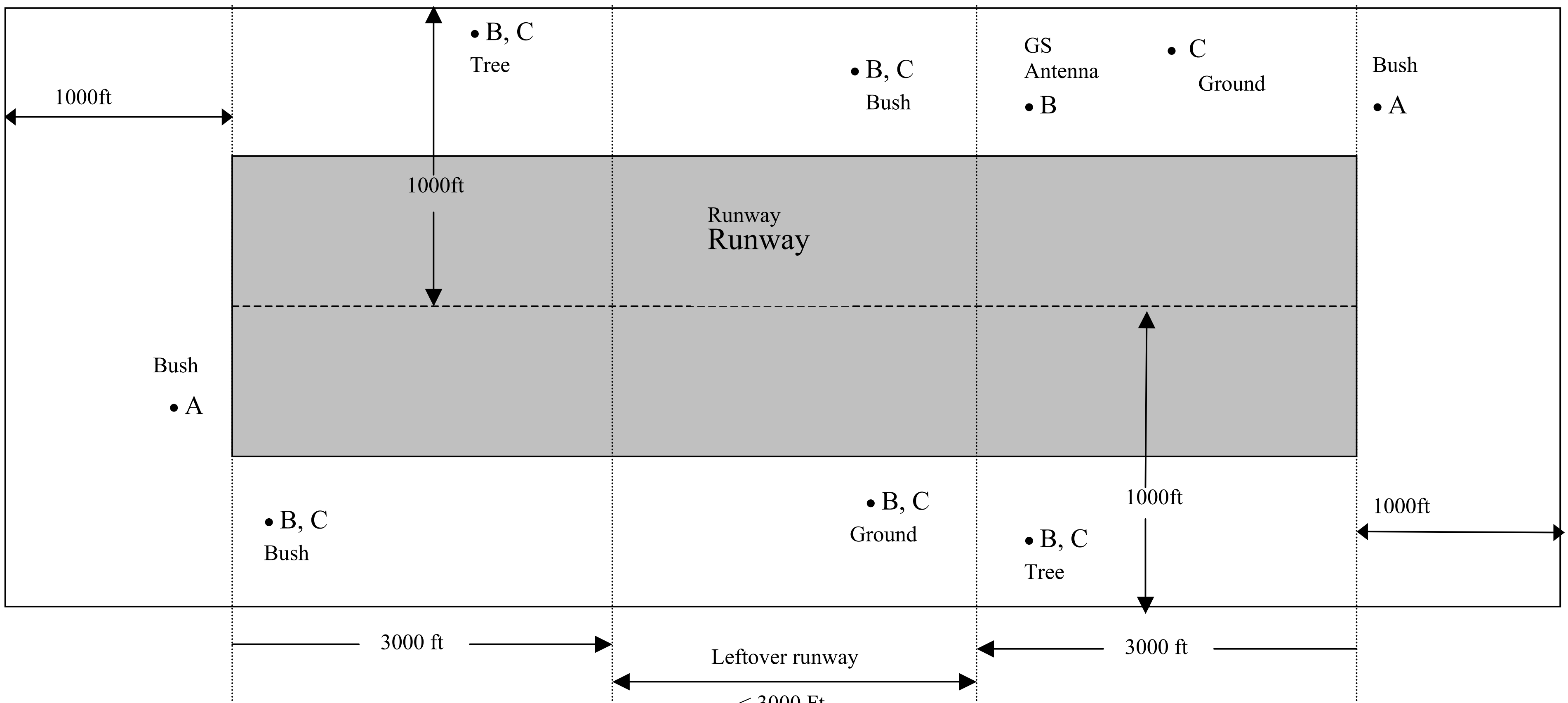


Fig 7.15

Obstruction Representation in the Primary Area shall include the:

A – Highest Obstruction Outward from the runway end.
B – Highest Obstruction in each 3000 ft (Approximately) primary section on each side of the runway.
C – Highest non-manmade obstruction in each 3000 ft (Approximately) primary section on each side of the runway.

Not to Scale

Top View of Primary Surface / Clear Zone Obstructions
9,000 to 12,000 foot runways

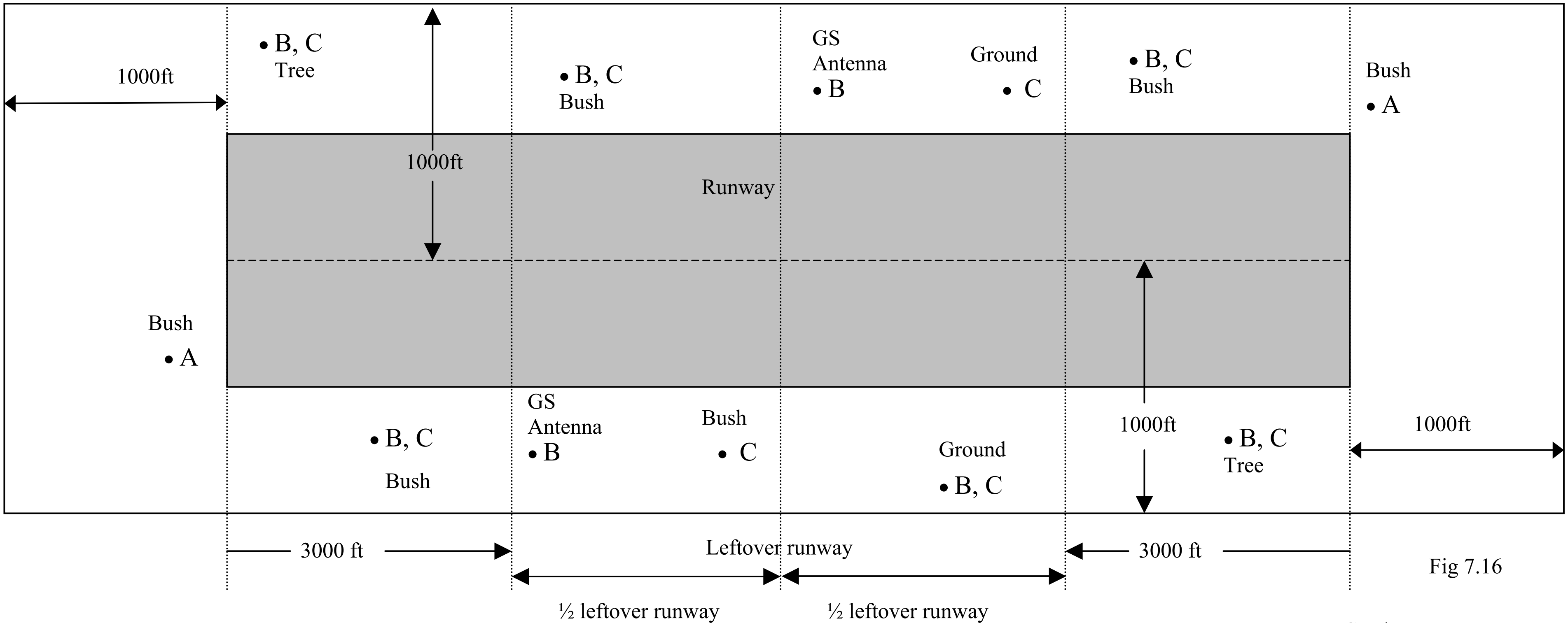


Fig 7.16

Not to Scale

Obstruction Representation in the Primary Area shall include the:

A – Highest Obstruction Outward from the runway end.
B – Highest Obstruction in each 3000 ft (Approximately) primary section on each side of the runway.
C – Highest non-manmade obstruction in each 3000 ft (Approximately) primary section on each side of the runway.

Top View of Primary Surface / Clear Zone Obstructions
12,000 to 15,000 foot runways

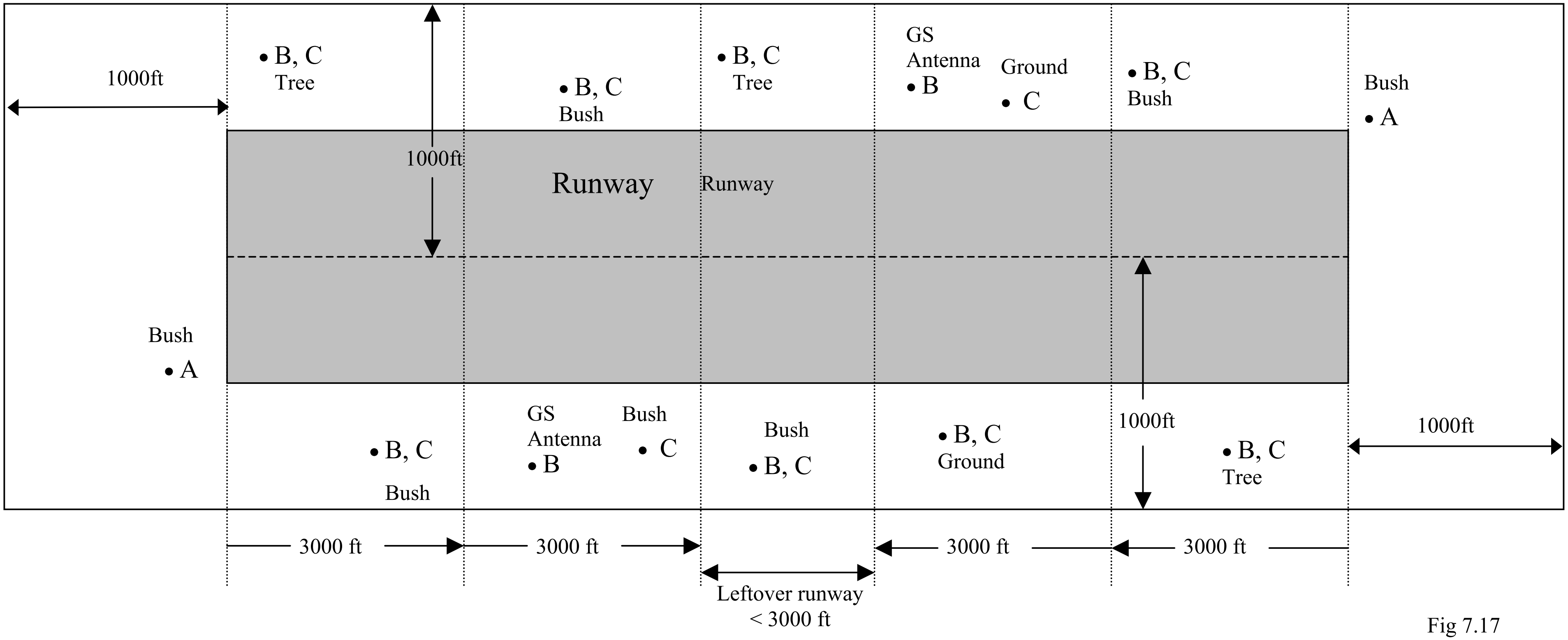


Fig 7.17

Not to Scale

Obstruction Representation in the Primary Area shall include the:

A – Highest Obstruction Outward from the runway end.
B – Highest Obstruction in each 3000 ft (Approximately) primary section on each side of the runway.
C – Highest non-manmade obstruction in each 3000 ft (Approximately) primary section on each side of the runway.

7.4.2 Approach Surface (See Figures 7.18 and 7.19)

- The highest obstruction/object that is both within the first 2,000 feet of an approach area and higher than the runway approach end. This object may or may not penetrate the approach surface and may be a non-obstructing estimated maximum elevation (EME) point.

- The most penetrating obstruction/object in the first 2,000 feet of an approach area. **(When there are multiple obstructions/objects that penetrate the slope at an equal value depict the one closest to the approach end of the runway.)**

- The highest approach obstruction/object, **and the most penetrating (may also be the highest)** in: (1) first 10,000 feet, (2) 10,000 - 20,000 feet, (3) 20,000 - 30,000 feet and (4) 30,000 - 42,332 feet. **When there are multiple obstructions/objects that penetrate each zone at an equal value depict the one closest to the approach end of the runway.**

7.4.3 Primary /Approach Transitional Surfaces (See Figures 7.20)

- The highest and most penetrating obstruction/object in each 3,000 feet (approximately) of each primary transition to the horizontal surface. **When there are multiple obstructions/objects that penetrate the transition surface at an equal value, depict the one closest to the runway.**

- The highest obstruction/object in each approach transition to the horizontal surface and the most penetrating (may also be the highest). **When there are multiple obstructions/objects that penetrate the transition surface at an equal value depict the one closest to the approach end of the runway.**

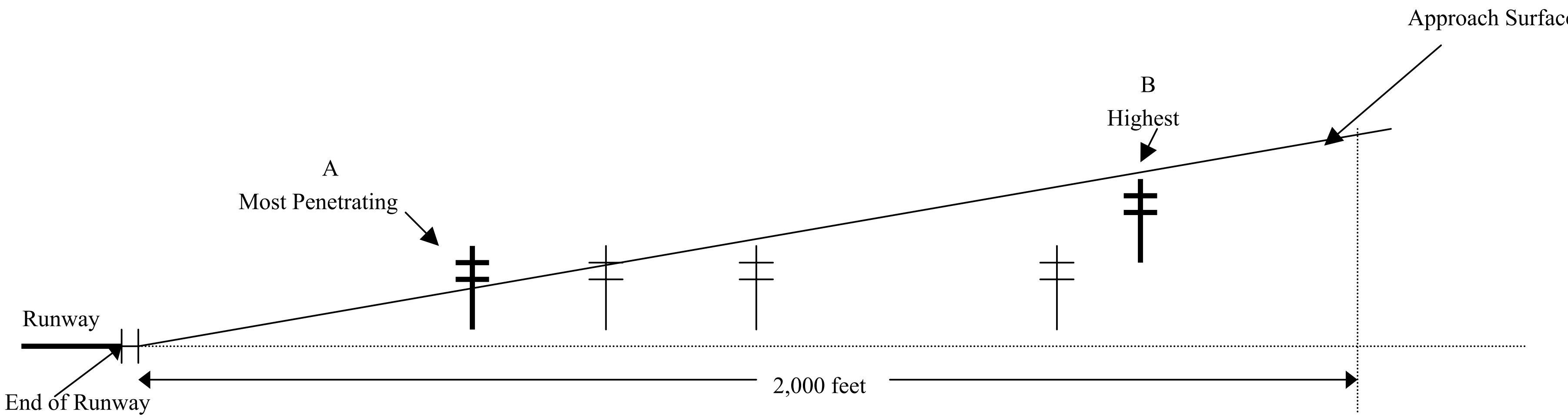
7.4.4 Inner Horizontal, Conical, and Outer Horizontal Surfaces (see figure 7.21)

- The highest **and the most penetrating (may also be the highest)** obstruction/object in the inner horizontal, conical and outer horizontal surface area in each quadrant of the runway area as defined by the meridian and parallel intersecting at the center point of the runway. **When there are multiple obstructions/objects that penetrate the horizontal or conical area at an equal value depict the one closest to the runway surface.**

7.4.5 Conical/Outer Horizontal Transitional Surfaces (see figure 7.22)

- The highest obstruction/object in the conical/outer horizontal transitional surface and the most penetrating (may also be the highest). **When there are multiple obstructions/objects that penetrate the Conical/Outer Horizontal transition surface at an equal value depict the one closest to the approach surface.**

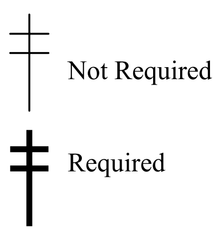
Side View of Approach Surface Obstructions
First 2000 feet



Object representation in the first 2000 feet of an Approach Area shall include the:

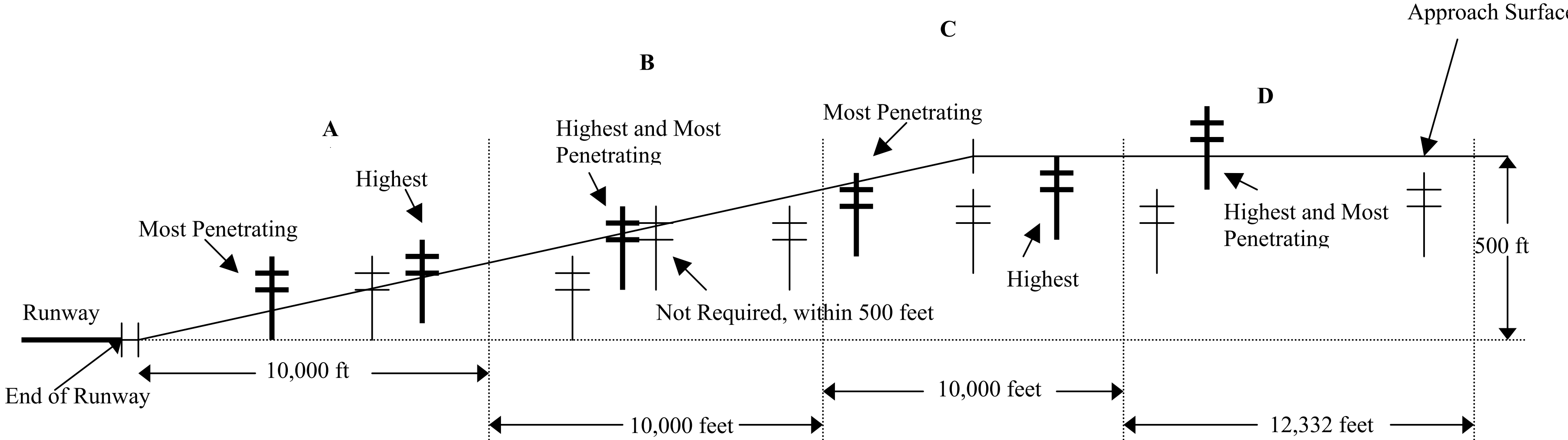
A – Most Penetrating Obstruction
B – Highest object above the runway end (this object may not penetrate approach surface)

Fig. 7.18



Not to Scale

Side View of Approach Surface Obstructions



Obstruction representation in an approach area shall include the highest and most penetrating object/obstruction in the:

Fig. 7.19

A - First 10,000 feet of the approach area
B – 10,000 - 20,000 feet of the approach area
C – 20,000 - 30,000 feet of the approach area
D – 30,000 - 42,332 feet of the approach area

Not Required

Required

Not to Scale

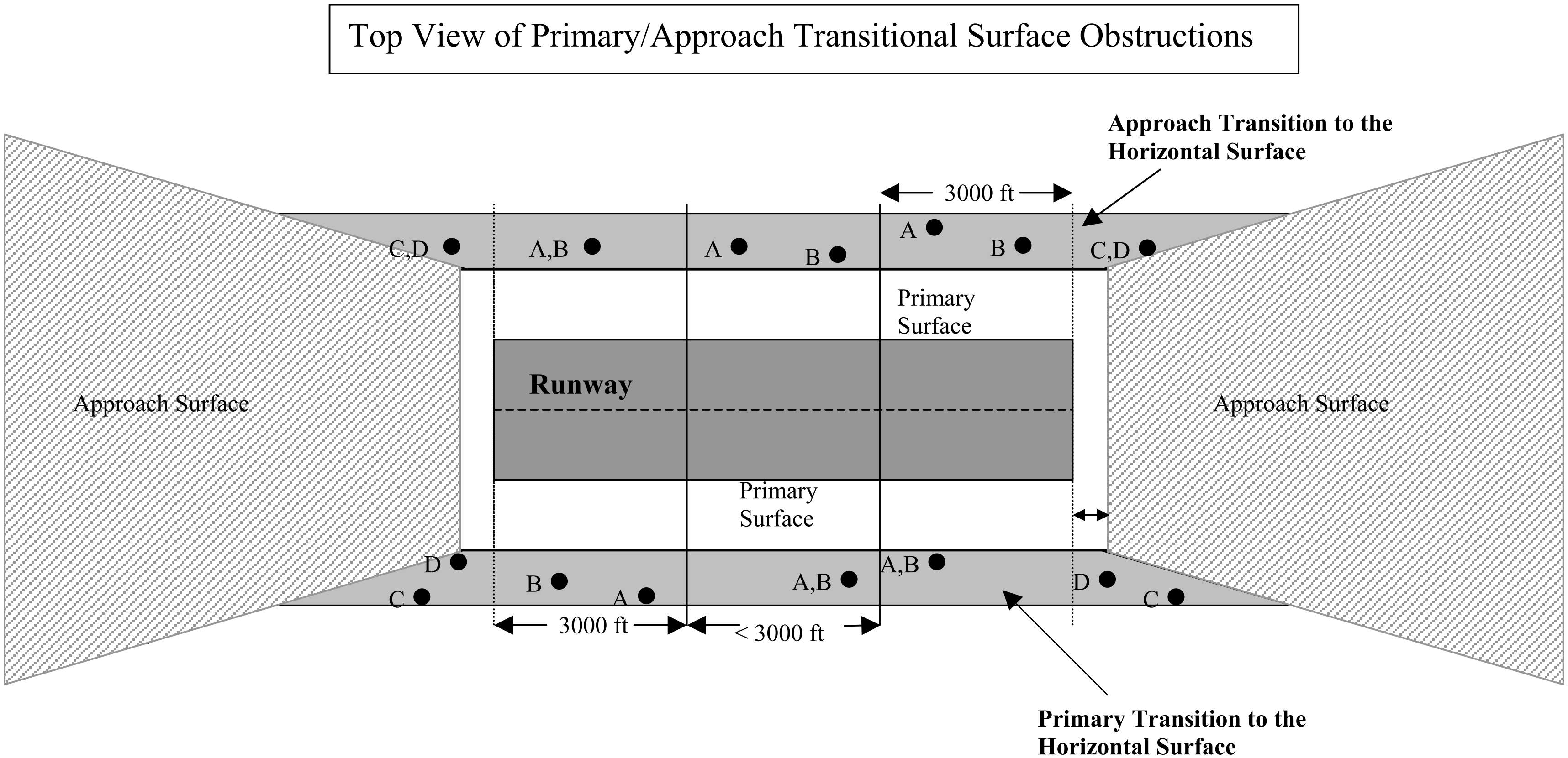


Fig 7.20

Obstruction representation in Transition areas shall include the:

A- Highest obstruction in each 3,000 feet (approximately) of each primary transition to the horizontal surface
B- Most penetrating obstruction in each 3000 feet (approximately) of each primary transition to the horizontal surface.
C- Highest obstruction in each approach transition to the horizontal surface
D- Most penetrating obstruction in each approach transition to the horizontal surface

Not to Scale

Top View of Inner Horizontal, Conical and Outer Horizontal Surface Obstructions

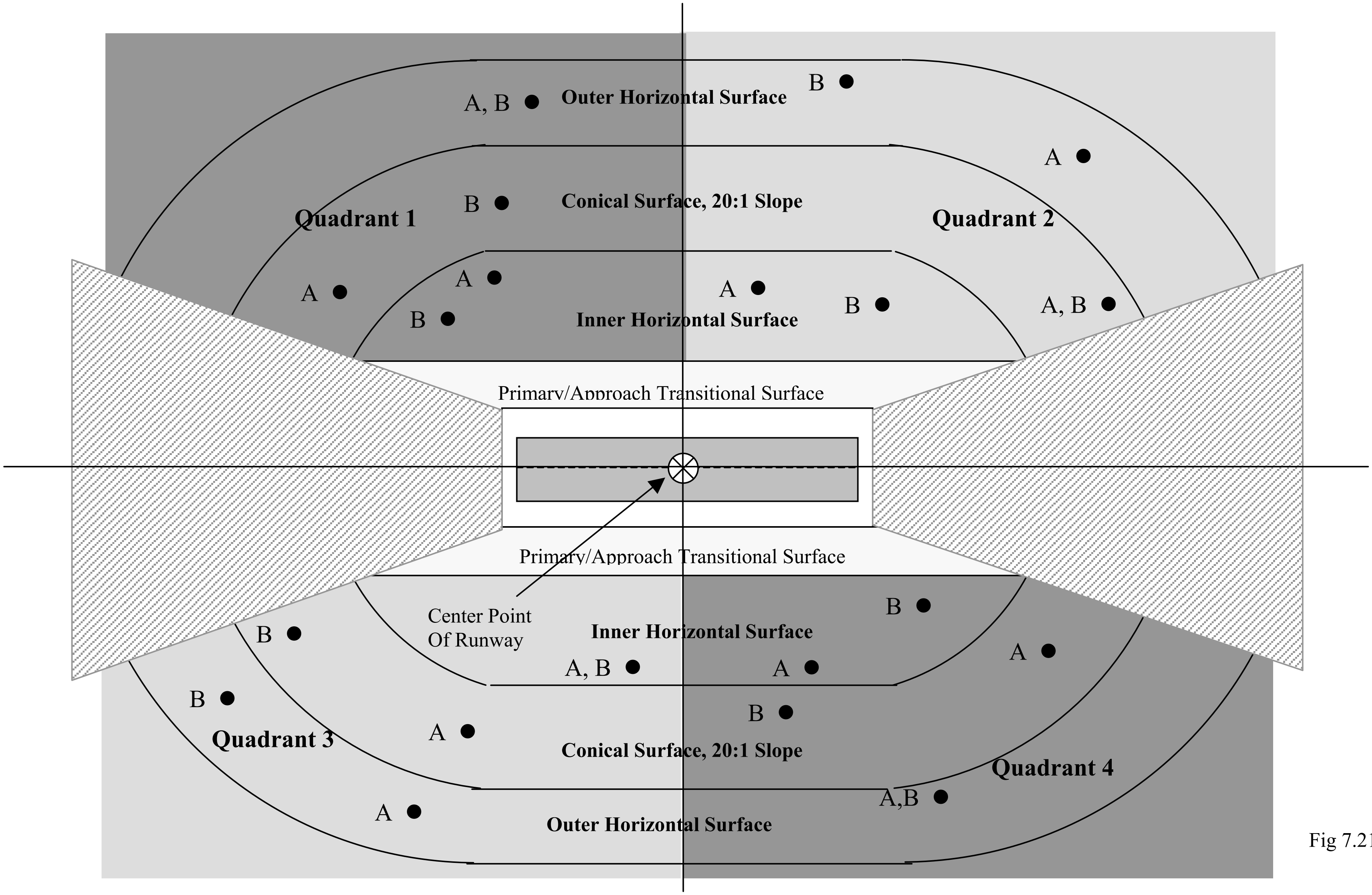


Fig 7.21

A Highest obstruction in the Inner Horizontal, Conical, and Outer Horizontal Surface for each Quadrant

Not to Scale

B Most penetrating obstruction in the Inner Horizontal, Conical and Outer Horizontal Surface for each Quadrant

Top View of Conical/Outer Horizontal Transitional Surface Obstructions

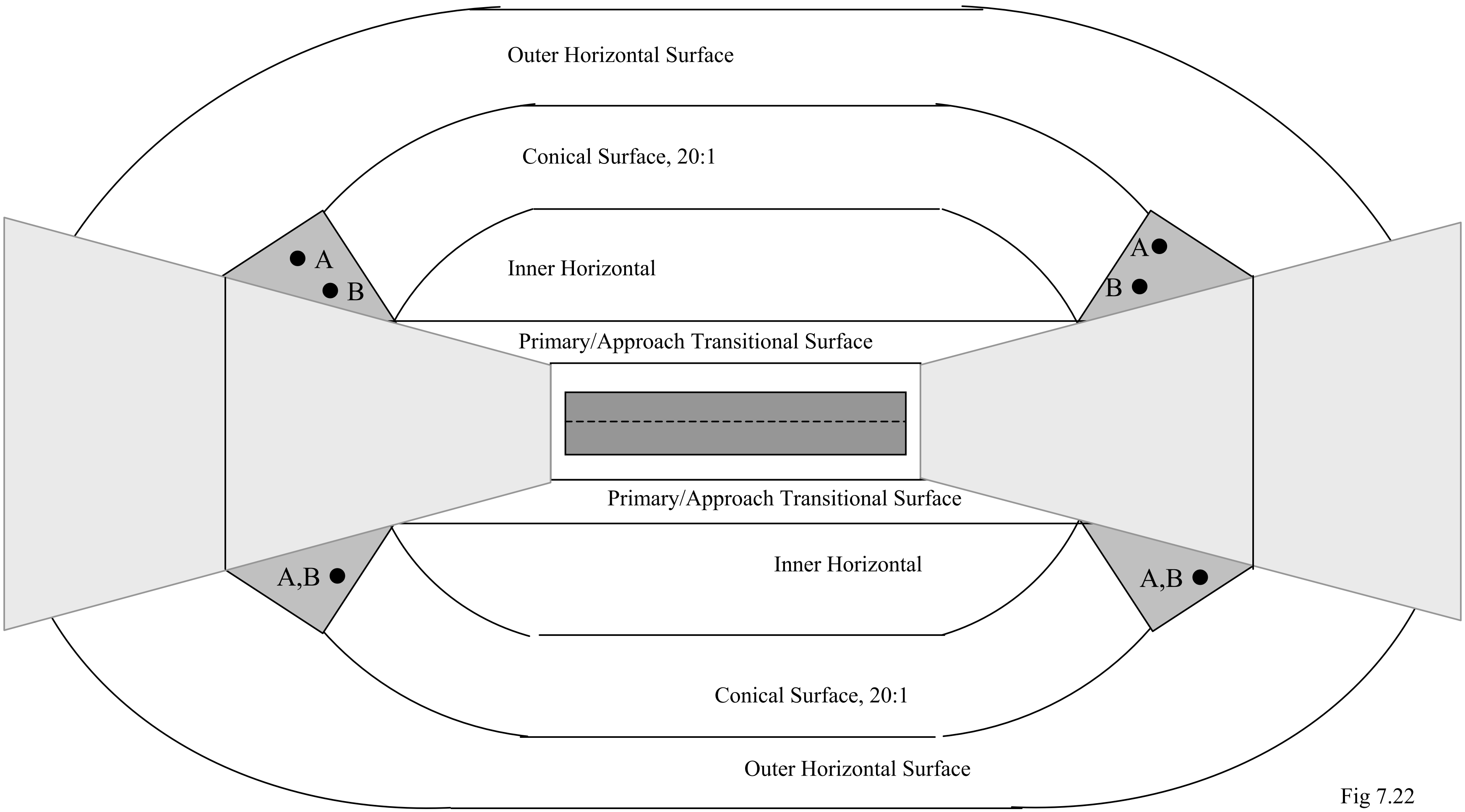


Fig 7.22

A. Highest object in either the Conical/Outer Horizontal Transition Surface.
B. Most Penetrating obstruction in either the Conical/Outer Horizontal Transition Surface.

Not to Scale

7.4.6 Obstructing Areas (See Figure 7.23)

An obstructing area must be considered if it meets the highest/most penetrating or the highest manmade or non-manmade obstruction criteria within one or more OIS zones of one or more OIS's and are considered homogenous regions if they impact multiple zones or multiple OIS's.

An obstruction/object representation within the limits of each obstructing area is to be compiled on the survey. This representation shall include the following:

- The highest obstruction/object within each obstructing area.

- The highest obstruction/object within that portion of an obstructing area that penetrates an approach surface.

- The highest obstruction/object within that portion of an obstructing area that penetrates a primary surface.

In some cases, strict adherence to the obstruction/object selection criteria listed above may result in congestion or inadequate obstruction/object representation. To minimize these situations, the following guidelines shall be followed in object selection:

- If obstructions/objects that are found in the obstructing area in the primary area or the first 10,000 feet of an approach area and are located within 100 feet of each other, the lower obstruction/object may be omitted.

- If obstructions/objects that are found in the obstructing area outside the primary or first 10,000 of an approach area and are located within 500 feet of each other, the lower obstruction/object may be omitted.

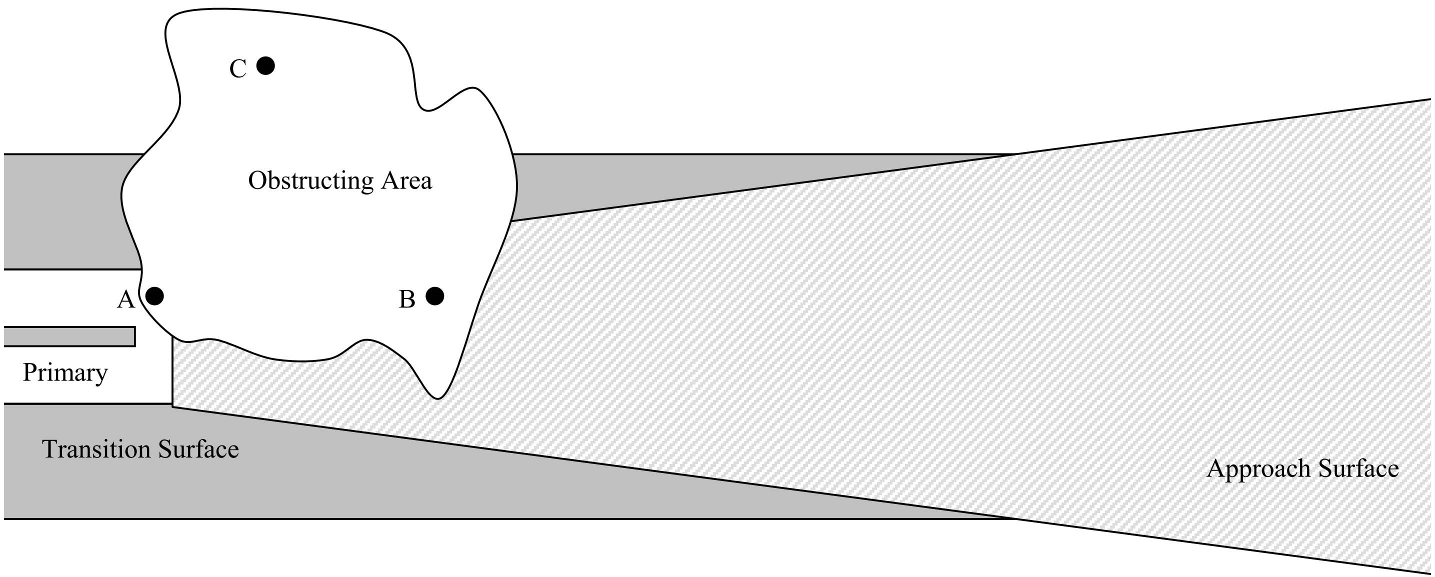
- When a required obstruction/object is omitted because of congestion, a replacement object/objects shall be selected if possible that meets spacing requirements.

Note: Obstruction/objects found in any obstructing area do not supersede those required obstruction/objects found in each OIS.

8. METEOROLOGICAL APPARATUS

Meteorological apparatus is not required unless it is to be carried as an obstruction.

Obstruction Representation in Obstruction Areas



Obstruction Representation in an obstructing area shall include the:

A- Highest obstruction in the Primary Area
B- Highest obstruction penetrating an approach surface
C- Highest obstruction in the obstructing area

See text when objects/obstructions congestion occurs

Fig 7.23

Not to Scale

II. TERMINAL AERONAUTICAL GNSS GEODETIC PROGRAM

SURVEY SPECIFICATIONS

1. GEODETIC CONTROL REQUIREMENTS

Geodetic Datum: WGS 84, as defined by the WGS 84 ellipsoid and seven (7) orientation parameters of Global Positioning Week 1150 (G1150), is the required datum. Surveys shall originate on a WGS 84 control quality station located on the airfield property.

Stations recognized as WGS 84 control stations are:
- The International Terrestrial Reference Frame (ITRF)
- The European Terrestrial Reference Frame (ETRF)
- The ITRF coordinates of Continuously Operating Reference Stations (CORS)
- High Accuracy Relative Network (HARN) if determined relative to the ITRF
- SIRGAS stations
- NGA Geodetic Absolute Sequential Positioning (GASP) derived point positions are preferred.
- Additionally, stations positioned by connections to WGS 84 control stations and meeting control position absolute accuracy requirements (the combined errors of all positioning processes, expressed in a root sum square sense per component, may not exceed WGS 84 control requirements in any component) shall be acceptable.

Stations *NOT* recognized as WGS 84 control positions are: Positions determined by datum transformation or shift will not be accepted as WGS 84 control positions. However, re-registration of demonstrably consistent existing surveys to NGA recognized WGS 84 control stations may be acceptable provided the quality of the resulting data demonstrably meets program objectives. In all cases NGA shall be consulted concerning plans to transform or shift existing data sets.

Heights: WGS 84 ellipsoid heights and orthometric heights interpolated with respect to NGA's Earth Gravitational Model 1996 (EGM96) geoid shall constitute the required data set. *Although several locally oriented vertical datum's exist that are, in a relative sense, more precisely defined than the EGM96 (± 1m, 1σ), none offer the accuracy (from the global perspective) needed to support world-wide GPS controlled flight.* Airfield vertical data registered to mean sea level or any other vertical datum will not be accepted in lieu of EGM96 orthometric heights. In cases where technical, political, or other considerations mandate reference to another datum, EGM96 orthometric heights shall be presented in addition to any other datum.

1.1 VERIFICATION AND INDEPENDENT CHECKS

General: All coordinates must be verified by independent observations. Triangles must contain enough measurements to demonstrate closure within the specifications of Appendix B. Networks of more than 3 stations must be adjusted by least squares and the variance/co-variance matrices of the adjustment of the observations must demonstrate that the coordinates meet the accuracy requirements specified in Appendix C.

WGS 84 Control: An independent check on the WGS 84 position adopted for the project Primary Airfield Control Station (PACS) shall be performed. 2 data sets are required. **Examples** of acceptable methods are given below. It should be noted that all of these methods involve some process-specific risks due to inability to conveniently download, correct, and post-process data in the field. Due to the high cost of re-deployment, the surveyor should make every attempt to ensure that **adequate data** is collected to support computation by several methods.

Two (2) 12-hour non-contiguous data sets processed with GASP. The sets should be collected at different stations in the network, e.g. the PACS and SACS.

Two (2) 12-hour data sets processed with the Jet Propulsion Laboratory's GPS Inferred Positioning System (GIPSY) software. The sets should be collected at different stations in the network, e.g. the PACS and SACS.

One (1) GASP solution derived from one (1) 12-hour data set and a GIPSY solution derived from (1) 12-hour data set.

One (1) GASP solution derived from one (1) 12-hour data set and a relative GPS tie to a NGA recognized WGS 84 control station.

Relative GPS ties to two 2 NGA recognized WGS 84 control stations yielding the WGS 84 control station accuracy as stated in Appendix C.

Note: GASP & GIPSY position reductions will be performed by NGA. You may forward RINEX data at any 5-second collection interval combination. Ensure that the true vertical height (height from ground to the electrical center of antenna) is inserted within the RINEX data file. Send data to the following:

By U.S. mail:
NGA
C/o PRGA/Geodetic Surveys Branch
Attn: TAGGS Program
3838 Vogel Road. MS L-20
Arnold, MO 63010

By our FTP site:
ftp.nima.mil/pub/gg/airfield_info
Please inform the Geodetic Surveys Branch that you are sending data by this method before you do so.
surveys@NGA.MIL
(314) 263-4819

RINEX data sent by mail may be on a zip disk or CD-ROM formatted for IBM compatible computers.

All Other Coordinates: Redundant GPS occupations, check angles, check distances must be performed and the results must demonstrate acceptable closure.

1.2 GEODETIC CONTROL STATIONS

Number of Stations: Each airport must have one Primary Airport Control Station (PACS) and at least two Secondary Airport Control Stations (SACS). Establishing three SACS is highly recommended.

Location: The PACS and SACS shall be located within the airfield property and placed appropriately to support classical/conventional survey observations. The geometric figure of an equilateral triangle with sides of approximately 1 kilometer should be used as a model. Consideration should be given to stability, permanence, and utility (accessibility, visibility, and potential sources of interference with GPS signals).

Station Monuments: Different types of monuments will be appropriate for different locations and ground conditions on the aerodrome/heliport and it is for the surveyor, with the guidance of aviation administration, the airport director, or other legitimate authority, to decide on the most appropriate type. Additionally, investigation should be made prior to the installation of survey monuments to ensure that underground cables and services will not be affected by the installation. In order of preference, the choices for monuments of PACS and SACS are:

- On bed rock

- On a concrete platform or pillar

- A stainless steel rod driven to refusal

- A one-meter spike

Name: Each survey station must be assigned (and preferably labelled or stamped with) a unique name such that there is no doubt as to its provenance or identity. An unambiguous numbering system, identifying the aerodrome/heliport, year and station number should be used. The recommended naming convention is to use the last three letters of the International Civil Aviation Organization (ICAO) designation code and a sequential number. For example, the ICAO identifier for Lambert St. Louis International is KSTL. The PACS and SACS would be named “STL 1”, “STL 2”, and “STL 3”. If this naming convention already exists at the airfield, the next number in the sequence should be used for newly established stations. However, guidance provided by Federal Aviation Administration (FAA), ICAO, the national administration, or other appropriate authority (including airport management) should be judiciously considered in the naming process and conditions such as the use of pre-existing marks or the preferences of the entity controlling the airfield may dictate that another naming convention be used. In all cases the surveyor should avoid the practice of establishing new monuments solely to satisfy a naming convention.

Labels: Uniform labels (e.g. stamped disks) may be used at individual aerodrome/heliports for all survey stations. Existing survey marks if appropriately located (*refer to 1.2: Location*) may be used, but no changes should be made to their labelling. Any substantial topographic surface feature may also be used as survey monument, provided the feature is clearly marked to identify the exact point of survey. All stations should be defined to within ±0.002 meter and the station name should be clearly evidenced in stamping, durable paint or other durable medium.

2. AIRFIELD FEATURES

Runway Points: The 3-dimensional positions of the runway ends, thresholds, overrun (stopway) ends; the touchdown zone elevation (TDZE) and a vertical profile of the runway must be determined. In the TDZ, vertical profile points must be measured at 100-foot intervals for the first 3000 feet of the useable runway beginning at each threshold. In the remaining portion of the runway the points may be spaced to produce an adequate runway vertical profile as long as the plane of the vertical gradient between any two adjacent published runway points does not depart by more than one foot from the runway surface.

Instrument Landing System (ILS): The 3-dimensional positions of all ILS components must be determined. The ILS normally consists of the following electronic components: Localizer, Glide Slope (GS), Outer Marker, Middle Marker, Inner Marker and Compass Locator. The point of survey for each component is explained in appendix A. **NOTE**: The point of survey for an end fire type glide slopes is different from that of traditional glide slopes. End fire type glide slopes are primarily used along the coastline, as they take into account tidal effects. These glide slopes are considerably larger than traditional glide slopes.

Microwave Landing System (MLS): The 3-dimensional positions of all MLS components must be determined to the plot points as explained in Appendix A. NOTE: The MLS is not widely used.

Terminal Navigation Aids: The 3-dimensional positions of all Terminal Navigation Aids will be surveyed. Terminal Navigation Aids are in close proximity to the airport. Contact the airport manager to determine locations. e.g. Non-Directional Beacon (NDB), Distance Measuring Equipment (DME), ASR, Air Route Surveillance Radar (ARSR), Localizer, Glide Slope, etc.

Visual NAVAIDs: The latitude and longitude of all Visual NAVAIDs must be determined. e.g. precision Approach Path Indicator (PAPI), Visual Approach Slope Indicator (VASI), Runway End Indicator Lights (REILS) Approach Lights, Rotating Beacon, etc.

Glide Slope Abeam Point: The abeam point can be a calculated location but the preferred method is direct measurement. It is defined as the point on the runway centerline at which the physical location of the point of survey on the Glide Slope device lies perpendicular to the runway centerline. The height of this point may be interpolated from the vertical profile information as appropriate.

Runway Crown and Airport Elevation: The highest point on each runway and the highest point of all of the usable runway surfaces must be determined.

Obstacles: The 3-dimensional position of selected objects limiting or impeding non-precision area navigation approach and departure must be determined. Diagrams of the areas of concern surrounding the runway and the arbitrary heights of obstacles are presented in the Section I, figures 7.1 - 7.22.

NOTE: Additional information on the precise plot points of survey for all NAVAIDs and other features is provided in Appendix A.

2.1 FRANGIBLE OBJECTS

All **frangible objects** are **not covered** under this program. Frangible objects are objects designed to breakaway such as, runway marker signs, taxiway signs, wind socks, anemometers, approach light systems, etc. **Do not** survey frangible navigational aids (except those specified in paragraph 2, Airfield Features), meteorological apparatus, parked aircraft, and mobile or temporary objects (i.e. construction equipment, dirt/debris piles, etc.).

2.2 PHOTO-IDENTIFIABLE POINTS

The 3-dimensional positions of at least 10, but no more than 20, well-defined (in a photogrametric sense) points must be determined. The surveyor's knowledge of the photogrametric process and research of available sources prior to the field campaign will directly influence the quality of the result and should also influence the surveyor's decisions relative to the number of points surveyed.

3. SURVEY ACCURACY AND PRECISION

Accuracy: In Appendix C, the accuracy requirements are expressed (root sum square of the accumulated process errors), per component (latitude, longitude, and ellipsoid height), at the 90% confidence region; to include the accuracy of the NGA recognized WGS 84 control station.

Precision: In Appendix B, the precision requirements are expressed (root sum square of the accumulated process errors, less the absolute accuracy estimate of the PACS) per component (latitude, longitude, and ellipsoid height), at the 90% confidence region, with respect to the PACS.

4. SURVEY DATA ACQUISITION REPORT/PUBLICATION

A document containing the final results relating to any surveyed portion of the project must be produced and should contain the following information:

1) A narrative containing the following information:

   a) The method used to establish WGS 84 control including the names of WGS 84 control stations used.

   b) A description of the method(s) used to extend control to all other points.

   c) Describe the equipment, procedures, and software used in the performance of the survey.

   d) For GPS procedures, describe the collection scenarios, and epoch intervals used.

   e) Describe and explain any events or conditions witnessed during the data acquisition phase that may bear on the validity of the data.

2) A table containing the results for each object positioned during the project. Note: All accuracy values are estimates of absolute accuracy with respect to WGS 84. A sample is provided in Table 1. The Table shall include the following information:

   a) A unique point identifier (name)

   b) An abbreviated description of the object positioned

   c) The WGS 84 Latitude (DD MM SS.SSS)

   d) The Latitude hemisphere (N/S)

   e) The WGS 84 Longitude (DDD MM SS.SSS)

   f) The Longitude hemisphere (E/W)

   g) The WGS 84 Ellipsoid height (meters) (MMMM.MMM)

   h) The WGS 84 Ellipsoid height (feet) (FFFF.FF)

   i) The EGM96 Orthometric height (meters) (MMMM.MMM)

   j) The EGM96 Orthometric height (feet) (FFFF.FF)

   k) The Latitude accuracy (WGS 84 absolute accuracy mmm.mmm)

l) The Longitude accuracy (WGS 84 absolute accuracy mmm.mmm)

m) The Ellipsoid height accuracy (mmm.mmm)

3) A description of the computational processes including:

   a) A comprehensive account of the GPS vector processing or classical/conventional surveying calculations. The software name, version number, and relevant optional settings should be discussed.

   b) A comprehensive account of the least square adjustment process including analysis of the variance/covariance matrices. The software name, version number, weighting and weighting rationale should be discussed.

   c) An accounting of precision values with respect to the PACS (as specified by FAA or ICAO as applicable) is required. The information may be presented in the form of certification that all precision requirements were met, by exception, or in tabular format as appropriate.

4) Descriptions of all survey control monuments in accordance with standard procedures and using the standard description forms for control stations that include a brief narrative, coordinates, sketch and photographs.

5) Descriptions of all photo control points measured for the project using the standard description forms for photo control points that include a brief narrative, coordinates, sketch and photographs.

6) The following disclaimer.

Enclosed is a copy of the field survey report for Airfield XXXXXX. This report presents WGS-84 positional and height information in compliance with ICAO requirements for geodetic control stations, runways, navigation aids, and many of the potential obstacles for safe approach to and departure from Airfield XXXXXX. Please note with caution that the obstruction information presented represents only a subset of the potential obstacles in the vicinity of Airfield XXXXXX and may not include all the obstacle data required for a specific application. The data in this report should be supplemented by maps, charts, other pertinent information available (such as construction projects), and an inspection of the airfield and vicinity during the development and evaluation of GNSS procedures.

NGA is developing a process to further enhance the obstacle data for airfields and to provide terrain information beyond the year 2000. The results will be available as soon as the production processes allows.

7) For archival of the survey data for each airfield survey, the following information should be provided.

    a) Any other technical, historical, administrative, logistical or other information bearing on the quality of the data or the completion of the project. Sketches, diagrams, detailed station descriptions, photographs, maps, electronic files (the installation GIS for example) and other documents should be provided for archiving if acquired during the course of the project.

    b) A copy of all raw data collected on the project and copies of all intermediate files produced during the process.

Table 1: Sample data sheet

1. WGS 84 Geodetic Control Stations

STATION		**LAT (ϕ)**	**LONG (λ)**	**ELL Ht (h)**	**ELL Ht (h)**	**ORTHO Ht**	**ORTHO Ht**	**WGS 84 Accuracy (meters)**		
Name	Description	Deg Min Sec	Deg Min Sec	**(meters)**	**(feet)**	**(meters)**	**(feet)**	ϕ	λ	h
DLF A	Primary Airfield Control Station (PACS)	N 29 21 16.953	W100 46 46.180	304.258	998.22	327.898	1075.78	0.411	0.411	0.411
DLF B	Secondary Airfield Control Station (SAC)	N 29 22 08.439	W100 46 52.487	307.856	1010.02	331.485	1087.55	0.411	0.411	0.411
BM&T.T. AD7 NO (DLF C)	Secondary Airfield Control Station (SAC)	N 29 21 39.738	W100 46 04.648	302.844	993.58	326.475	1071.11	0.411	0.411	0.411

2. Imagery Control Points

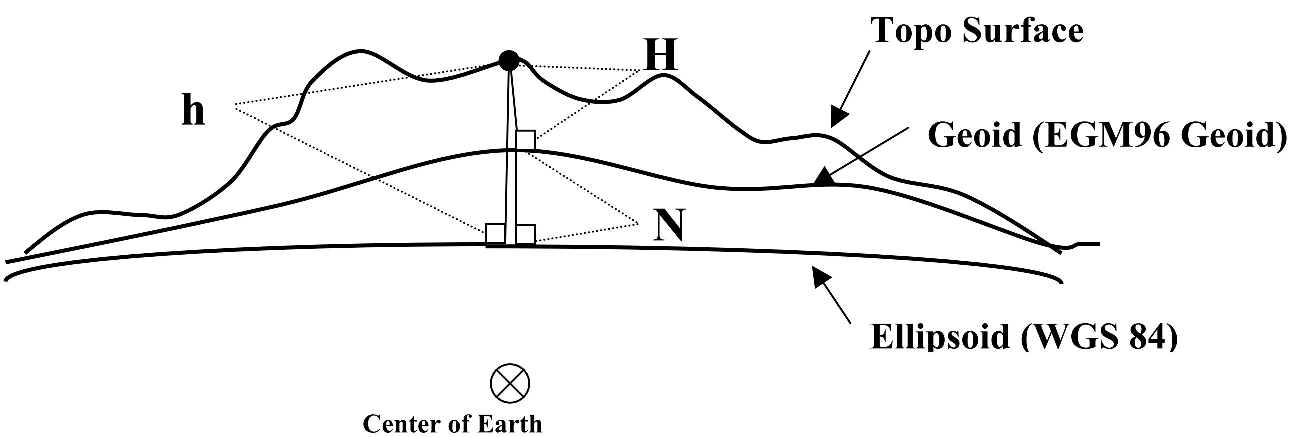
STATION		**LAT (ϕ)**	**LONG (λ)**	**ELL Ht (h)**	**ELL Ht (h)**	**ORTHO Ht**	**ORTHO Ht**	**WGS 84 Accuracy (meters)**		
Name	Description	Deg Min Sec	Deg Min Sec	**(meters)**	**(feet)**	**(meters)**	**(feet)**	ϕ	λ	h
PP01	Photo Control Point	N 29 21 50.878	W100 47 43.081	306.505	1005.59	330.139	1083.13	0.411	0.411	0.412
PP02	Photo Control Point	N 29 21 37.385	W100 48 36.941	295.676	970.06	319.315	1047.62	0.411	0.411	0.412
PP03	Photo Control Point	N 29 20 43.705	W100 48 05.423	316.728	1039.13	340.373	1116.71	0.411	0.411	0.413
PP04	Photo Control Point	N 29 20 13.661	W100 46 47.246	296.754	973.60	320.400	1051.18	0.412	0.411	0.414
PP05	Photo Control Point	N 29 20 53.764	W100 45 55.102	298.901	980.64	322.539	1058.20	0.411	0.411	0.413
PP06	Photo Control Point	N 29 21 57.638	W100 46 04.832	303.348	995.23	326.976	1072.75	0.411	0.411	0.412
PP07	Photo Control Point	N 29 22 21.701	W100 46 59.752	307.939	1010.30	331.537	1087.72	0.411	0.411	0.412
PP08	Photo Control Point	N 29 21 27.873	W100 47 55.939	310.485	1018.65	334.123	1096.20	0.411	0.411	0.412
PP09	Photo Control Point	N 29 20 58.985	W100 47 37.178	310.708	1019.38	334.350	1096.95	0.411	0.411	0.412
PP10	Photo Control Point	N 29 20 30.424	W100 47 40.173	304.453	998.86	328.100	1076.44	0.411	0.411	0.413
PP11	Photo Control Point	N 29 20 44.935	W100 46 50.917	306.846	1006.71	330.487	1084.27	0.411	0.411	0.412
PP12	Photo Control Point	N 29 20 46.130	W100 46 20.748	300.884	987.15	324.524	1064.71	0.411	0.411	0.412
PP13	Photo Control Point	N 29 21 08.568	W100 46 59.803	305.735	1003.07	329.374	1080.62	0.411	0.411	0.411
PP14	Photo Control Point	N 29 21 09.882	W100 47 16.750	311.798	1022.96	335.437	1100.51	0.411	0.411	0.412
PP15	Photo Control Point	N 29 21 35.820	W100 47 20.874	304.974	1000.57	328.610	1078.12	0.411	0.411	0.412

III. TERMINAL AERONAUTICAL GNSS GEODETIC SURVEY DELIVERY SPECIFICATION

1. GENERAL DATA REQUIREMENTS

1.1 ABSOLUTE ACCURACY

The accuracy of the TAGGS data is expressed in terms of absolute accuracy per component (latitude, longitude, ellipsoid height), 90%, with respect to NGA recognized realizations of WGS 84. Orthometric height and associated accuracy estimates will be expressed with respect to the NGA Earth Gravity Model 1996 (EGM96) geoid. The absolute accuracy of positions established by differential GPS, classical/conventional or other methods will be estimated by Root Sum Square (RSS) calculations including the absolute accuracy of the WGS 84 control station and the relative accuracy of the process(s) used to extend the control.



H = Orthometric Height
h = Ellipsoid Height (approx. N + H)
N = Geoid Height

Figure 2: Illustration of various heights referenced in this specification.

1.2 DATUM

1.2.1 Horizontal datum. The horizontal datum for this TAGGS product shall be WGS84 as identified in NIMA TR 8350.2.

1.2.2 Vertical datum. The vertical datum for this TAGGS product shall be Earth Gravitational Model 1996 (EGM96) Geoid as identified in NIMA TR 8350.2.

1.3 UNIT OF MEASURE

Length, width, and heights for the TAGGS are expressed in both Meters and Feet. Distances are measured in meters with the exception of defining overall airfield coverage extent. Overall airfield coverage extent is defined in nautical miles as well as feet. Angles are expressed in degrees.

1.4 COORDINATE SYSTEM

TAGGS data shall be stored in decimal degrees as geographic coordinates with southern and western hemispheres having a negative sign for latitude and longitude, respectively. The geographic coordinates shall be stored in double precision (8 byte).

1.5 SECURITY CLASSIFICATION

CD-ROM containing Airfield Initiative data shall be UNCLASSIFIED.

Plot Points of NAVAIDS

Electronic NAVAIDS	Plot Point (Horizontal)	Plot Point (Elevation)
Air Route Surveillance Radar	Axis of antenna rotation, if covered center of cover	Ground level through plumb line
Airport Surveillance Radar (ASR)	Axis of antenna rotation, if covered center of cover	Ground level through plumb line
Instrument Landing System (ILS)	(5)	(5)
Localizer (LOC)	Center of Antenna support structure	Ground level through plumb line
Middle Marker (MM)	Center of Antenna Array	Not required
Inner Marker (IM)	Center of Antenna Array	Not required
Back Course Marker (BCM)	Center of Antenna Array	Not required
Outer Marker (OM)	Center of Antenna Array	Not required
Glide Slope (GS)	Center of Antenna support structure	Ground level through plumb line (2)
Instrument Landing System/Distance Measuring Equipment (ILS/DME)	(1)	(3)
Distance Measuring Equipment (DME) not frequency paired	Center of Antenna Cover	Center of Antenna Cover
Frequency paired with Localizer (LOC/DME)	(1)	(3)
Frequency paired with Non-Directional Beacon (NDB/DME)	(1)	(3)
Frequency paired with Microwave Landing System Azimuth Guidance (MLSAZ/DME)	(1)	(3)
Frequency paired with VHF Omni Directional Radio Range/Distance Measuring Equipment (VOR/DME)	(1) Center of Antenna Cover	(3) Ground level through plumb line
Fan Marker (FM)	Center of Antenna Array	Not required
Localizer type Directional Aid (LDA)	Center of Antenna support structure	Ground level through plumb line
Microwave Landing System Azimuth Guidance (MLSAZ)	Phase center reference point	Phase center reference point
Microwave Landing System Elevation Guidance (MLSEL)	Phase center reference point	Phase center reference point
Non-Directional Radio Beacon (NDB)	Center of Antenna Array	Not Required
Simplified Directional Facility (SDF)	Center of Antenna support structure	Not required
Tactical Air Navigation (TACAN)	Center of Antenna Cover	Ground level through plumb line
VHF Omni-Directional Radio Range (VOR)	Center of Antenna Cover	Ground level through plumb line
VHF Omni Directional Radio Range and TACAN (VORTAC)	Center of Antenna Cover	Ground level through plumb line
Differential GPS	Phase Center of Antenna	Phase Center of Antenna
Microwave Landing System (MLS)	Phase center reference point	Phase center reference point

Precision Approach Radar (PAR)	(4)	Ground level through plumb line
PAR Touchdown Reflectors	Phase center reference point	Phase center reference point
Locator (without DME IM) Beacon (L)	Center of Antenna Array	Not required
Visual NAVAIDS	**Plot Point (Horizontal)**	**Plot Point (Elevation)**
Visual Glideslope Indicators		
Precision Approach Path Indicator (PAPI)	Plot point is the center of the light array. Since PAPI systems usually have two or four light units installed in a row-aligned perpendicular to the runway centerline, the array center "plot point" will be between the units.	Not required (Ground elevation for survey purposes only)
Pulsating Visual Approach Slope Indicator (PVASI)	Center of the projecting unit	Not required
Visual Approach Slope Indicator (VASI)	Center of the near, middle (if present), and far VASI bars. Where two light units exist in a bar, the "plot point" shall be midway between the two units	Not required (Ground elevation for survey purposes only)
Tri-Color Visual Approach Slope Indicator (TRCV)	Center of the light array	Not required
"T"-Visual Approach Slope Indicator (TVASI)	Center of the light array	Not required
Approach Light Systems	Center of the beginning and end light units in the system of lights.	Not required
Runway End Identifier Lights	Center of each light	Not required
Airport Beacon	The axis of light rotation.	Not required

(1) If instruments are not collocated (having the same horizontal position), each instrument will be surveyed separately.
(2) End Fire type plot point: phase center of antenna reference point/phase center of antenna reference point.
(3) DME elevations are required only when the DME is frequency paired with an ILS or MLS.
(4) The horizontal survey point for PAR facilities will be as follows:
  (a) For antennas mounted on a mobile van, the center of the van.
  (b) For antennas mounted on a rotating equipment housing, the axis of rotation.
  (c) For antennas hard mounted on a fixed structure, the center of the azimuth antenna. If the antenna is covered, the HSP will be the center of the antenna cover.
(5) The horizontal and vertical survey points for each component of the Instrument Landing System (localizer, glide slope, approach lighting, and inner, middle, and outer markers) should be surveyed separately.

Precision Table

POINTS OF INTEREST	Precision Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)
GEODETIC CONTROL STATIONS						
Primary Airport Control Station (PACS)	N/R	N/R	N/R	N/R	N/R	N/R
Secondary Airport Control Stations (SACS)	0.03	0.04	0.03	0.04	0.05	0.05
RUNWAY POINTS						
Runway Ends	0.3	0.07	0.3	0.07	1	1
Airport Reference Point (ARP)	0.3	N/R	0.3	N/R	30	N/R
Touch Down Zone Elevation (TDZE)	N/R	0.07	N/R	0.07	1	1
Threshold Ends	0.3	0.07	0.3	0.07	1	1
Overrun (stopway) Ends	0.6	0.07	0.6	0.07	1	1
In the TDZ, vertical profile points must be measured at 100-foot intervals for the first 3000 feet of the useable runway beginning at each threshold. In the remaining portion of the runway the points may be spaced to produce an adequate runway vertical profile as long as the plane of the vertical gradient between any two adjacent published runway points does not depart by more than one foot, 0.3 meter, from the runway surface.	0.6	0.07	0.6	0.07	N/R	0.3

Precision Table

POINTS OF INTEREST	Precision Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)
ELECTRONIC NAVAIDS						
Air Route Surveillance Radar (ARSR)	6	30	6	30	100	N/R
Airport Surveillance Radar (ASR)	6	30	6	30	100	N/R
Instrument Landing System (ILS)						
Localizer (LOC)	0.3	0.3	0.3	0.3	3	3
Middle Marker (MM)	6	N/R	6	N/R	3	N/R
Inner Marker (IM)	6	N/R	6	N/R	3	N/R
Back Course Marker (BCM)	15	N/R	15	N/R	3	
Outer Marker (OM)	15	N/R	15	N/R	3	N/R
Compass Locator	15	N/R	15	N/R	3	N/R
Glide Slope (GS)	0.3	0.07	0.3	0.07	3	3
Distance Measuring Equipment (DME)						
Frequency paired with LOC	0.3	0.3	0.3	0.3	3	30
Frequency paired with MLSAZ	0.3	0.3	0.3	0.3	3	30
Frequency paired with NDB	(1)	N/R	(1)	N/R	3	N/R
Frequency paired with VOR	(1)	N/R	(1)	N/R	3	N/R
not frequency paired	(1)	N/R	(1)	N/R	3	N/R
Fan Marker	(1)	N/R	(1)	N/R	3	N/R
Localizer Type Directional Aid (LDA)	0.3	0.3	0.3	0.3	3	3
MLS Azimuth Guidance (MLSAZ)	0.3	0.3	0.3	0.3	3	3
MLS Elevation Guidance (MLSEL)	0.3	0.07	0.3	0.07	3	3
Non-directional Beacon (NDB)	(1)	N/R	(1)	N/R	3	N/R
Simplified Directional Facility (SDF)	0.3	0.3	0.3	0.3	3	3

Precision Table

POINTS OF INTEREST	Precision Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)
ELECTRONIC NAVAIDS						
Tactical Air Navigation (TACAN)	(1)	30	(1)	30	3	3
VHF OMNI Directional Range (VOR)	(1)	30	(1)	30	3	3
VOR/TACAN (VORTAC)	(1)	30	(1)	30	3	3
VISUAL NAVAIDS						
Visual Glideslope Indicators						
Precision Approach Path Indicator (PAPI)	6	N/R	6	N/R	N/R	N/R
Pulsating Visual Approach Slope Indicator (PVASI)	6	N/R	6	N/R	N/R	N/R
Visual Approach Slope Indicator (VASI)	6	N/R	6	N/R	N/R	N/R
Tri-Color Visual Approach Slope Indicator (TRCV)	6	N/R	6	N/R	N/R	N/R
“T”-Visual Approach Slope Indicator (TVASI)	6	N/R	6	N/R	N/R	N/R
Approach Light Systems	6	N/R	6	N/R	N/R	N/R
Runway End Identifier Lights	6	N/R	6	N/R	N/R	N/R
Airport Beacon	(1)	N/R	(1)	N/R	N/R	N/R

Precision Table

POINTS OF INTEREST	Precision Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)
ENROUTE NAVAIDS						
NAVAIDS within 7 nautical miles of the airport	15	30	15	30	100	N/R
METEOROLOGICAL APPARATUS						
Except as obstruction	N/R	N/R	N/R	N/R	N/R	N/R
PHOTO IDENTIFIABLE (PI) POINTS						
All points	.15	.15	N/R	N/R	N/R	N/R
OBSTACLES						
Within the area defined for the program						
Any object 500 or more ft AGL	6	1	6	1	(2)	(2)
Within 1000 ft Clear Zones						
Highest obstruction in each.	6	1	6	1	(2)	(2)
The highest non-manmade obstruction in each (may be the terrain).	6	1	6	1	(2)	(2)
Within Primary Surface						
The highest obstruction and the highest non man-made obstruction/object in each 3,000-foot (approximately) section of the primary area on each side of the runway.	6	1	6	1	(2)	(2)

Precision Table

POINTS OF INTEREST	Precision Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)
Within Approach Surfaces						
The highest obstruction/object that is both within the first 2,000 feet of an approach area and higher than the runway approach end. This object may or may not penetrate the approach surface and may be a non-obstructing EME point.	6	1	6	1	(2)	(2)
The most penetrating obstruction/object in the first 2,000 feet of an approach area. (When there are multiple obstructions/objects that penetrate the slope at an equal value, depict the one closest to the approach end of the runway.)	6	1	6	1	(2)	(2)
The highest obstruction/object within10,200 feet of the runway end	6	1	6	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 10,200 feet of the runway end.	6	1	6	1	(2)	(2)
The highest obstruction/object within 20,200 feet of the runway end	15	1	15	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 20,200 feet of the runway end	15	1	15	1	(2)	(2)
The highest obstruction/object within 30,200 feet of the runway end	15	1	15	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 30,200 feet of the runway end	15	1	15	1	(2)	(2)
The highest obstruction/object within 40,200 feet of the runway end	15	1	15	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 40,200 feet of the runway end	15	1	15	1	(2)	(2)
The highest obstruction/object within the primary surface.	6	1	6	1	(2)	(2)
The most penetrating obstruction/object within the primary surface.	6	1	6	1	(2)	(2)

Precision Table

POINTS OF INTEREST	Precision Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)
Transitional Surfaces						
The highest obstruction/object if within 500 feet of the primary surface.	6	1	6	1	(2)	(2)
The most penetrating obstruction/object if within 500 feet of the primary surface.	6	1	6	1	(2)	(2)
The highest obstruction/object if beyond 500 feet from the primary surface and less than 200 ft AGL	15	6	15	6	(2)	(2)
The most penetrating obstruction/object if beyond 500 feet from the primary surface and less than 200 ft AGL	15	6	15	6	(2)	(2)
The highest obstruction/object if beyond 500 feet from the primary surface and 200 or more feet AGL	15	1	15	1	(2)	(2)
The most penetrating obstruction/object if beyond 500 feet from the primary surface and 200 or more ft AGL	15	1	15	1	(2)	(2)
Inner Horizontal Surfaces						
The highest obstruction/object in each surface.	15	1	15	1	(2)	(2)
Conical Surfaces						
The highest obstruction/object in each surface.	15	1	15	1	(2)	(2)
The most penetrating obstruction/object in each surface.	15	1	15	1	(2)	(2)
Outer Horizontal Surfaces						
The highest obstruction/object in each surface.	15	1	15	1	(2)	(2)

Precision Table

POINTS OF INTEREST	Precision Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)	Rel (ϕ/λ)	Rel (h)
Stopway length	N/R	N/R	N/R	N/R	N/R	N/R
Stopway end	0.3	0.15	0.3	0.15	N/R	N/R
Displaced Threshold	0.3	0.15	0.3	0.15	N/R	N/R
Supplemental profile points	6	0.15	6	0.15	N/R	N/R
Abeam Points						
Localizer (LOC)	0.3	N/R	0.3	N/R	3	3
Offset Localizer Type Directional Aid (LDA)	0.3	N/R	0.3	N/R	3	3
Offset Simplified Directional Facility (SDF)	0.3	N/R	0.3	N/R	3	3
Glide Slope (GS)	0.3	0.15	0.3	0.15	3	3
Microwave Landing System Elevation Guidance (MLSEL)	0.3	0.15	0.3	0.15	3	3
Microwave Landing System Azimuth Guidance (MLSAZ)	0.3	N/R	0.3	N/R	3	3
Precision Approach Radar (PAR)	0.3	N/R	0.3	N/R	3	3
PAR Touchdown Reflector	0.3	0.15	0.3	N/R	3	3

Note (1)The precision requirement is 20 ft or 6.10 meters when the object is located on the airport and 50-ft or 15.24 meters for all other locations.
Note (2) ICAO defines obstacles in the approach/takeoff area, in the circling areas, and en-route.

The reference datum for the orthometric heights of all points will be the EGM 96 geoid.

When multiple obstructions/objects equally penetrate (within ± ½ the accuracy requirement) the sloped portion of an OIS, depict the obstruction/object closest to the approach end of the runway.

Accuracy Table

POINTS OF INTEREST	Accuracy Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)
GEODETIC CONTROL STATIONS						
Primary Airport Control Station (PACS)	0.42	0.42	≤2	≤2	0.6	0.6
Secondary Airport Control Stations (SACS)	0.42	0.42	≤2	≤2	0.6	0.6
RUNWAY POINTS						
Runway Ends	0.42	0.42	≤2	≤2	0.6	0.6
Airport Reference Point (ARP)	0.42	0.42	≤2	≤2	0.6	0.6
Touch Down Zone Elevation (TDZE)	0.42	0.42	≤2	≤2	0.6	0.6
Threshold Ends	0.42	0.42	≤2	≤2	0.6	0.6
Overrun (stopway) Ends	0.73	0.42	≤2	≤2	0.6	0.6
Runway Profile: At least 4 surveyed points along the runway surface are required in all cases. The points should include the runway ends and 2 other points located as to divide the runway into 3 approximately equal sections. Additionally, if the gradient between any two surveyed points departs the actual runway surface by more than 0.3 meter, supplemental points shall be established until the standard is met.	0.73	0.42	≤2	≤2	0.6	0.6

Accuracy Table

POINTS OF INTEREST	Accuracy Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)
ELECTRONIC NAVAIDS						
Air Route Surveillance Radar (ARSR)	6	30	N/R	30	100	N/R
Airport Surveillance Radar (ASR)	6	30	N/R	30	100	N/R
Instrument Landing System (ILS)						
Localizer (LOC)	0.5	0.5	≤2	≤2	3	3
Middle Marker (MM)	6	N/R	6	N/R	3	N/R
Inner Marker (IM)	6	N/R	6	N/R	3	N/R
Back Course Marker (BCM)	15	N/R	15	N/R	3	N/R
Outer Marker (OM)	15	N/R	15	N/R	3	N/R
Compass Locator	N/R	N/R	N/R	N/R	3	N/R
Glide Slope (GS)	0.5	0.42	≤2	≤2	3	3
Distance Measuring Equipment (DME)						
Frequency paired with LOC	0.5	0.5	≤2	≤2	3	30
Frequency paired with MLSAZ	0.5	0.5	≤2	≤2	3	30
Frequency paired with NDB	(1)	N/R	(1)	N/R	3	N/R
Frequency paired with VOR	(1)	N/R	(1)	N/R	3	N/R
not frequency paired	(1)	N/R	(1)	N/R	3	N/R
Fan Marker	(1)	N/R	(1)	N/R	3	N/R
Localizer Type Directional Aid (LDA)	0.5	0.5	≤2	≤2	3	3
MLS Azimuth Guidance (MLSAZ)	0.5	0.5	≤2	≤2	3	3
MLS Elevation Guidance (MLSEL)	0.5	0.42	≤2	≤2	3	3
Non-directional Beacon (NDB)	(1)	N/R	(1)	N/R	3	N/R
Simplified Directional Facility (SDF)	0.5	0.5	≤2	≤2	3	3

Accuracy Table

POINTS OF INTEREST	Accuracy Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)
ELECTRONIC NAVAIDS						
Tactical Air Navigation (TACAN)	(1)	30	(1)	30	3	3
VHF OMNI Directional Range (VOR)	(1)	30	(1)	30	3	3
VOR/TACAN (VORTAC)	(1)	30	(1)	30	3	3
VISUAL NAVAIDS						
Visual Glideslope Indicators	6	N/R	6	N/R	N/R	N/R
Precision Approach Path Indicator (PAPI)	6	N/R	6	N/R	N/R	N/R
Pulsating Visual Approach Slope Indicator (PVASI)	6	N/R	6	N/R	N/R	N/R
Visual Approach Slope Indicator (VASI)	6	N/R	6	N/R	N/R	N/R
Tri-Color Visual Approach Slope Indicator (TRCV)	6	N/R	6	N/R	N/R	N/R
"T"-Visual Approach Slope Indicator (TVASI)	6	N/R	6	N/R	N/R	N/R
Approach Light Systems	6	N/R	6	N/R	N/R	N/R
Runway End Identifier Lights (REIL)	6	N/R	6	N/R	N/R	N/R
Airport Beacon	(1)	N/R	(1)	N/R	N/R	N/R

Accuracy Table

POINTS OF INTEREST	Accuracy Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)
ENROUTE NAVAIDS						
NAVAIDS within 7 nautical miles of the airport	15	30	15	30	100	N/R
METEOROLOGICAL APPARATUS						
Except as obstruction	N/R	N/R	N/R	N/R	N/R	N/R
PHOTO IDENTIFIABLE (PI) POINTS						
All points	0.42	0.42	N/R	N/R	N/R	N/R
OBSTACLES						
Within the area defined for the program						
Any object 500 or more ft AGL	6	1	6	1	(2)	(2)
Within 1000 ft Clear Zones						
Highest obstruction in each.	6	1	6	1	(2)	(2)
The highest non-manmade obstruction in each (may be the terrain).	6	1	6	1	(2)	(2)
Within Primary Surface						
The highest obstruction and the highest non man-made obstruction/object in each 3,000 foot (approximately) section of the primary area on each side of the runway.	6	1	6	1	(2)	(2)

Accuracy Table

POINTS OF INTEREST	Accuracy Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)
Within Approach Surfaces						
The highest obstruction/object that is both within the first 2,000 feet of an approach area and higher than the runway approach end. This object may or may not penetrate the approach surface and may be a non-obstructing EME point.	6	1	6	1	(2)	(2)
The most penetrating obstruction/object in the first 2,000 feet of an approach area. (When there are multiple obstructions/objects that penetrate the slope at an equal value, depict the one closest to the approach end of the runway.)	6	1	6	1	(2)	(2)
The highest obstruction/object within10,200 feet of the runway end	6	1	6	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 10,200 feet of the runway end.	6	1	6	1	(2)	(2)
The highest obstruction/object within 20,200 feet of the runway end	15	1	15	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 20,200 feet of the runway end	15	1	15	1	(2)	(2)
The highest obstruction/object within 30,200 feet of the runway end	15	1	15	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 30,200 feet of the runway end	15	1	15	1	(2)	(2)
The highest obstruction/object within 40,200 feet of the runway end	15	1	15	1	(2)	(2)
The most penetrating obstruction/object (may also be the highest) within 40,200 feet of the runway end	15	1	15	1	(2)	(2)
The highest obstruction/object within the primary surface.	6	1	6	1	(2)	(2)
The most penetrating obstruction/object within the primary surface.	6	1	6	1	(2)	(2)

Accuracy Table

POINTS OF INTEREST	Accuracy Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)
Transitional Surfaces						
The highest obstruction/object if within 500 feet of the primary surface.	6	1	6	1	(2)	(2)
The most penetrating obstruction/object if within 500 feet of the primary surface.	6	1	6	1	(2)	(2)
The highest obstruction/object if beyond 500 feet from the primary surface and less than 200 feet AGL	15	6	15	6	(2)	(2)
The most penetrating obstruction/object if beyond 500 feet from the primary surface and less than 200 ft AGL	15	6	15	6	(2)	(2)
The highest obstruction/object if beyond 500 feet from the primary surface and 200 or more feet AGL	15	1	15	1	(2)	(2)
The most penetrating obstruction/object if beyond 500 feet from the primary surface and 200 or more feet AGL	15	1	15	1	(2)	(2)
Inner Horizontal Surfaces						
The highest obstruction/object in each surface.	15	1	15	1	(2)	(2)
The most penetrating obstruction/object in each surface.	15	1	15	1	(2)	(2)

Accuracy Table

POINTS OF INTEREST	Accuracy Requirements (expressed in meters)					
	NGA		FAA		ICAO	
	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)	WGS 84 (ϕ, λ)	WGS 84 (h)
Conical Surfaces						
The most penetrating obstruction/object in each surface.	15	1	15	1	(2)	(2)
The highest obstruction/object in each surface.	15	1	15	1	(2)	(2)
Outer Horizontal Surfaces						
The highest obstruction/object in each surface.	15	1	15	1	(2)	(2)
Stopway length	N/R	N/R	N/R	N/R	N/R	N/R
Stopway end	0.5	0.42	≤2	≤2	N/R	N/R
Displaced Threshold	0.5	0.42	≤2	≤2	N/R	N/R
Supplemental profile points	6	0.42	≤2	≤2	N/R	N/R
Abeam Points						
Localizer (LOC)	0.5	N/R	≤2	N/R	3	3
Offset Localizer Type Directional Aid (LDA)	0.5	N/R	≤2	N/R	3	3
Offset Simplified Directional Facility (SDF)	0.5	N/R	≤2	N/R	3	3
Glide Slope (GS)	0.5	0.42	≤2	≤2	3	3
Microwave Landing System Elevation Guidance (MLSEL)	0.5	0.42	≤2	≤2	3	3
Microwave Landing System Azimuth Guidance (MLSAZ)	0.5	N/R	≤2	N/R	3	3
Precision Approach Radar (PAR)	0.5	N/R	≤2	N/R	3	3
PAR Touchdown Reflector	0.5	N/R	≤2	N/R	3	3

Note (1) The accuracy requirement is 20 ft or 6.11 meters when the object is located on the airport and 50 ft or 15.25 meters for all other locations.
Note (2) ICAO defines obstacles in the approach/takeoff area, in the circling areas, and en-route.
The reference datum for the orthometric heights of all points will be the EGM 96 geoid.
When multiple obstructions/objects equally penetrate (within ± ½ the accuracy requirement) the sloped portion of an OIS, depict the obstruction/object closest to the approach end of the runway.
Distances (runway lengths, stopway lengths, etc.) shall be reported as horizontal.
Trigonometric leveling observations shall be the apparent vertical or zenith angle at the time of observation corrected for heights of instrument and target above station.